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THE PLANT DISEASE BULLETIN

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THE PLANT DISEASE SURVEY

SUPPLEMENT 8

Diseases of Cereal and Forage Crops

in the United States in 1919.

May 1, 1920

BUREAU OF PLANT INDUSTRY

UNITED STATES DEPARTMENT OF AGRICULTURE

PLANT DISEASE SURVEY

1919

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It should be understood that many other collaborators and pathologists have assisted in gathering data within the states but the following list includes those who actually furnished state reports to the Washington office.

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Washington.....	Dr. F. D. Heald
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	Prof. Anthony Berg
	Dr. J. L. Sheldon
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DISEASES OF CEREAL AND FORAGE CROPS IN THE UNITED STATES IN 1919.

Prepared by
A. G. Johnson* and R. J. Haskell.

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PRELIMINARY STATEMENT

The data on which the following summary of cereal and forage crop diseases is based were obtained from four principal sources:

1. Collaborators of the Plant Disease Survey as listed on the preceding page.
2. Crop disease specialists of the Bureau of Plant Industry.
3. Miscellaneous reports and records obtained by the Plant Disease Survey.
4. The records of the 1919 cereal disease survey conducted by the Office of Cereal Investigations, United States Department of Agriculture. This survey was made in 26 states, commencing in Alabama and Texas May 12 and 13, and ending in northern Idaho September 4.

The following table shows the states where surveys were conducted, the time of the work, and the number of fields visited in each state:

---

*Plant pathologist, Office of Cereal Investigations, temporarily transferred to the Plant Disease Survey, Bureau of Plant Industry.

Table 1. Number of fields of small grain inspected by men engaged in the cereal disease survey, 1919. Much of the information on which the summaries in the following pages are based was obtained from observations in these fields.

State	Time of Survey	Number of grain fields surveyed.			
		Wheat	Oats	Barley	Rye
New York	June 30-July 18	138	113	11	10
Pennsylvania	July 8-July 19	105	122	11	6
Maryland	June 11-July 12	164	4	--	2
Virginia	June 4-June 17	59	5	1	6
Kentucky	June 11-June 18	163	14	1	5
Tennessee	May 30-June 19	177	38	5	16
Georgia	May 14-May 28	39	23	--	3
Alabama	May 12-May 29	133	113	2	18
Texas	May 13-June 2	200	176	21	3
Oklahoma	June 3-June 10	98	33	9	1
Arkansas	June 6-June 10	12	8	--	1
Ohio	June 16-July 3	283	26	10	8
Indiana	June 16-July 19	596	254	36	28
Illinois	June 18-June 28				
	July 11-July 21	92	31	--	24
Wisconsin	July 16-Aug. 5	107	139	51	15
Minnesota	July 2-Aug. 19	520	280	111	128
Iowa	June 27-July 18	214	78	30	3
Missouri	May 26-June 28	562	101	6	16
North Dakota	Aug. 4-Aug. 8	53	11	7	1
Nebraska	June 27-July 3	67	13	4	1
Kansas	June 12-June 25	114	51	3	1
Montana	Aug. 5-Aug. 12	97	60	16	--
Colorado	June 17-July 26	154	20	22	--
Idaho	July 9-Sept. 4	283	94	32	--
Washington	July 2-Aug. 30	1081	72	43	3
California	May 19-July 18	593	109	298	6
United States	May 12-Sept. 4	6104	1988	730	305

WHEAT

Bunt caused by Tilletia laevis Kühn and T. tritici (Bjerk.) Wint.

Bunt occurred about as extensively during 1919 as the preceding year but losses from it are reported as being somewhat less on the whole. On the accompanying map are indicated the occurrence and estimated percentages of reduction in yield in the states where losses were reported. The estimated

losses from bunt in 1919 are summarized in bushels in Plant Disease Bulletin, Supplement 12, 1920.

It is to be noted that, in general, the average estimated percentages of loss from this disease were comparatively low. However, in a number of states very high percentages of bunt were reported as having occurred in individual fields. California leads with 90% reported from one field, and Washington is a close second with over 80% reported in one field and an even 80% in another, both in Whitman County. The following list gives the states in the order of highest percentages of bunt reported from individual fields. The states with less than 15% as maximum percentages are omitted.

Table 2. Highest percentages of bunt reported from individual fields in 1919.

States	Highest % bunt reported	States	Highest % bunt reported
California	90.	Iowa	28.
Washington	80.	Illinois	24.
Indiana	76.	Arkansas	23.
Idaho	66.	Colorado	22.5
Georgia	60.	Alabama	20.
Kansas	50.	Oklahoma	20.
Ohio	50.	New York	16.
Kentucky	48.	Minnesota	15.
Missouri	40.	Tennessee	15.
Nebraska	32.		

It is to be noted that three of the four highest percentages are from the far west where soil infestation by bunt is known to occur; namely, from California, Washington, and Idaho. The high percentages reported from Indiana, Georgia, Kansas, and Ohio would seem to bear out the known fact that high percentages of bunt can result without soil infestation; namely, when very smutty, susceptible, untreated seed is planted under conditions favorable for the development of this disease. Such unusually high individual percentages of loss so widely scattered over the country should speak volumes to the individual farmer in emphasizing to him personally the necessity of taking all feasible precautionary measures to avoid, so far as possible, any such losses in his own fields at any time in the future.

While high individual losses are of greatest interest and importance to individual farmers, high average losses are of greatest importance to the nation as a whole. Fortunately the highest average percentages of loss from bunt in 1919 did not occur uniformly in the major wheat producing states. However, the comparatively low average percentages of loss in those states aggregate a very large total.

The somewhat lesser amount of bunt in 1919 than in the previous year is no doubt chargeable to at least two groups of causes: (1) more intelligent attention to the use of cleaner seed, either from clean seed stocks or by use of suitable seed treatments; and (2) weather conditions just preceding, at, and immediately following, seeding time.

It is well known that high soil temperatures during the early seedling stage tend to inhibit bunt infections. Further, it was noted in Montana by Jennison that "drought tended to hold down amount of infection." In Idaho Hungerford and Wade showed experimentally that, with other things equal, the amount of smut tends to vary inversely with the dryness of the soil. No doubt the rather dry, warm spring in the spring wheat area tended to keep down the amount of bunt infection there. The rather high bunt infections in individual fields, reported from this area, may possibly be attributed to unusually early sowing or to some other local condition particularly favorable to bunt development.

Table 3. Summary of cereal disease survey data on the occurrence of bunt in wheat varieties in Washington in 1919.

a. Ten or more fields surveyed of each variety.

Variety	Total No. fields surveyed.	Total No. fields smutted.	% of fields smutted.	Average % smut in smutted fields.	Average % smut in all fields surveyed.
Early Baart	144	32	22.	1.3	.29
Fortyfold	147	122	83.	3.37	2.8
Jenkins' Club	40	29	73.	4.06	2.9
Jones' Fife	92	80	87.	3.24	2.8
Little Club	19	12	63.	1.6	1.
Marquis	93	6	6.	4.3	.27
Pacific Blue Stem	145	30	21.	1.43	.29
Red Chaff	21	9	43.	4.7	2.
Red Russian	86	76	88.	9.1	8.
Turkey Red	80	57	71.	1.3	.94
Wash. Hybrid No. 63	29	25	86.	7.08	6.1
Wash. Hybrid No. 123	21	17	81.	4.23	3.4
Wash. Hybrid No. 128	80	76	95.	5.2	4.9
Wash. Hybrid No. 143	47	35	74.	8.6	6.4

b. Fewer than ten fields surveyed of each variety.

California Gem	4	4	100.	1.	1.
Coppie	2	2	100.	1.	1.
Dicklow	8	2	25.	t	t
Kinney	1	1	100.	t	t
Red Allen	3	0	0.	0.	0.
Red Fife	1	1	100.	.25	.25
Triplet	5	4	80.	5.	4.
White Australian	1	1	100.	18.	18.

Table 4. Summary of cereal disease survey data on the occurrence of bunt in wheat varieties in Whitman County, Washington, in 1919.

a. Five or more fields surveyed of each variety.

Variety	Total No. fields surveyed.	Total No. fields smutted.	% of fields smutted.	Average % smut in smutted fields.	Average % smut in all fields surveyed.
Fortyfold	83	79	95.	3.6	3.4
Jenkins' Club	9	4	44.	3.7	1.6
Jones' Fife	6	5	83.	6.9	5.7
Little Club	15	11	73.	1.3	1.
Marquis	64	4	6.	6.4	.4
Pacific Blue Stem	25	7	28.	1.4	.4
Red Chaff	20	10	45.	4.3	2.1
Red Russian	67	65	97.	9.4	9.1
Turkey Red	6	5	83.	t	t
Wash.Hybrid No. 123	14	10	71.	.5	.4
Wash.Hybrid No. 128	7	7	100.	5.	5.
Wash.Hybrid No. 143	12	11	91.	3.5	3.

b. Fewer than five fields surveyed of each variety.

California Gem	4	4	100.	1.	1.
Coppie	1	1	100.	2.	2.
Early Baart	3	0	0.	0.	0.
Kinney	1	1	100.	t	t
Triplet	1	0	0.	0.	0.

Clearly, seed treatments were practiced more extensively than the preceding year ant this of course had its share in reducing the amount of bunt. Of the 6104 wheat fields inspected by the cereal disease survey men in the 26 states visited, 2220, or 36% were found to have been sown with treated seed. These data, together with the results, are summarized in Table 5 presented and discussed later.

Information on varietal resistanceto bunt, while fragmentary, is rather promising. Melchers reports that Heald is finding Kanred somewhat resistant to bunt in Washington. Certain promising selections are also being developed at the Washington Agricultural Experiment Station.

As to field evidence, bearing on disease resistant tendencies, it is at once evident that data gathered in the state of Washington are of most value because of the extensive soil infestation by bunt that occurs in that state. This is especially true for such counties as Whitman County, Washington, where wheat raising is unusually important and soil infestation is rather

Fig. 1. Relative percentages of fields of different wheat varieties smutted in Whitman County, Washington in 1919. Data from five or more fields of each variety covered by cereal disease survey. See Table 4.

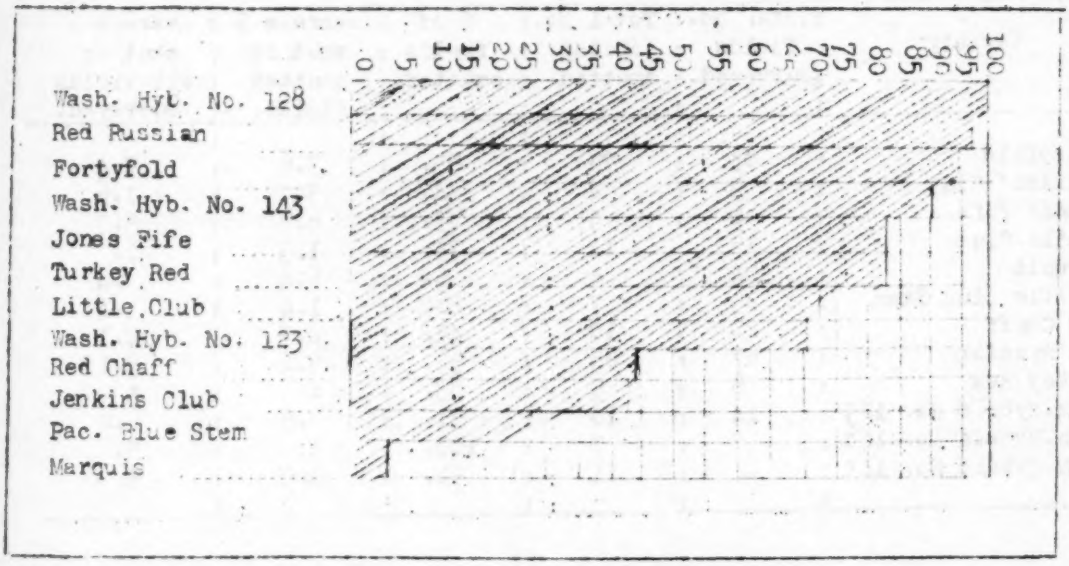
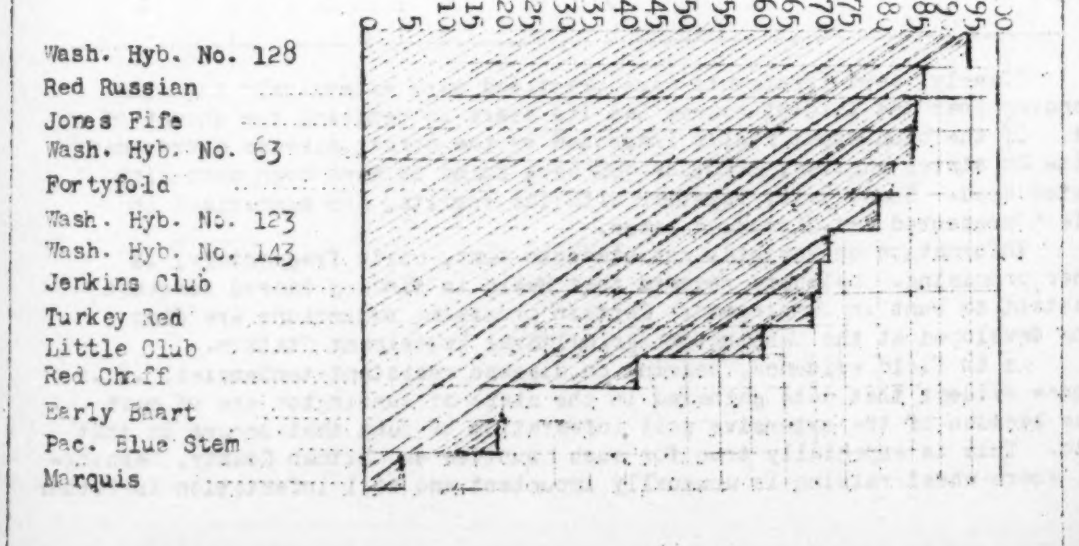


Fig. 2. Relative percentages of fields of different wheat varieties smutted in Washington in 1919. Data from ten or more fields of each variety covered by cereal disease survey. See Table 2.



general. On account of these conditions the cereal disease survey data from Washington have been gone over especially from this point of view, and the summaries indicate that certain wheat varieties tend to show some degree of resistance to bunt, at least they were found less constantly smutted than certain other varieties.

These data are summarized in Tables 3-4 and Figures 1-2. The data from Whitman County, while included in the state summaries, are also summarized separately for reasons stated above.

While it is conceded, in general, that data of this sort, for a number of reasons, are by no means as reliable as those from carefully conducted experimental tests, yet it may not be without significance that the same varieties appear at each of the two corresponding ends of the two graphs. That is, fields of Washington Hybrid No. 128 and Red Russian were found most constantly smutted and fields of Pacific Blue Stem and Marquis were found least constantly smutted. It should be added also that practically all of the bunt in Marquis was found in two fields in Whitman County where 17.5% and 8.1% respectively were recorded. Only traces of bunt were found in each of the other four fields of

Table 5. Summary of cereal disease survey data on bunt in fields inspected in 1919, sown with untreated and treated seed.

State	No. fields surveyed	No. fields with seed not treated	No. fields with seed treated	% bunt seed not treated	% bunt seed treated
New York	138	134	4	0.4	0
Pennsylvania	105	99	6	0.2	0
Maryland	164	144	20	0.8	0.3
Virginia	59	54	5	0.3	0.2
Kentucky	163	100	63	0.5	t
Tennessee	177	142	35	0.6	t
Georgia	39	13	26	6.	t
Alabama	133	65	68	1.3	t
Texas	200	171	29	0.02	t
Oklahoma	98	93	5	0.3	t
Arkansas	12	3	9	7.6	0
Ohio	283	260	23	2.1	0.3
Indiana	596	501	95	0.9	t
Illinois	92	90	2	0.3	0
Wisconsin	107	101	6	t	0
Minnesota	520	425	95	0.5	t
Iowa	214	207	7	0.5	t
Missouri	562	390	172	1.6	t
North Dakota	53	15	38	0.	0
Nebraska	67	50	17	3.	0.8
Kansas	114	93	21	1.2	t
Montana	97	83	14	0.14	0
Colorado	154	86	68	1.9	t
Idaho	283	128	155	4.7	1.7
Washington	1081	108	973	2.9	2.5
California	593	329	264	2.	2.5

Marquis found smutted out of the total of 93 inspected in the state. Further, the two fields showing 80% bunt, previously referred to, were in both cases Red Russian. A number of high percentages of bunt were also found in Washington Hybrid No. 128, Washington Hybrid No. 143, Jones Fife, Turkey Red, and less commonly in other varieties.

Similar data from other states apparently do not show outstanding constancy, either in the frequency with which the different varieties were found smutted, or in the percentages of bunt when smutted. This is as might be expected, since in other states than Washington soil infestation by bunt is absent or less common and hence, as a result there is no constancy in exposure to infection. However, the summarized data are suggestive from a number of points of view and are therefore given in the accompanying tables.

One rather outstanding question suggested by the data is as to why Marquis is smutted more commonly in most of the central and eastern states than in Washington. The data are not at hand as to whether or not this variety, when found smutted in Washington and elsewhere, was attacked by the same species of smut. If they were they might throw some light on the question. It is conceivable that different varieties of wheat may vary in their relative susceptibility to the two species of Tilletia which cause bunt.

As to the control of bunt by seed treatment, the results reported are satisfactory in that they show practicability and efficiency, especially where properly carried out, except in the far west where soil infestation occurs. Data bearing on this phase gathered by the cereal disease survey men are summarized in Table 5.

It is to be noted that almost perfect control resulted very generally except in Idaho, Washington, and California, which latter is explainable by the fact that soil infestation occurs in those states.

In general, some form of the wet formaldehyde method, dilution 1 pint to 30 or 40 gallons, was most commonly used in the central and eastern states, while some form of the copper sulphate method usually proved most satisfactory in the far west where soil infestation occurs.

As to the extent of seed treatment of wheat, collaborators were requested to estimate the percentage of farmers in their states who disinfect seed wheat for the prevention of bunt. The following reports were received:

Virginia: "This varies greatly in different counties according to the activities of the county agents. About 10% treat for bunt. Bluestone is more generally used than formaldehyde." Fromme.

West Virginia: "There are a very fair number of farmers, possibly 10%, who treat wheat for bunt." Giddings.

Tennessee: "Five per cent." Essary.

South Carolina: "Thirty five per cent." Seal.

Louisiana: "Practically none." Edgerton.

Arkansas: "About 85% of the farmers treated their wheat for bunt in the fall of 1918, and the losses this year were greatly reduced. Fewer treated their grain in 1919, and an increase of bunt may be expected for next year since there were some bunt-infected fields in most localities. About half of the farmers use bluestone and half 1-40 formaldehyde." Elliott.

Ohio: "Thirty per cent." Selby.

Michigan: "Probably 10%." Coons and Bessey.

Minnesota: "Nineteen per cent of fields visited." Bisby.

Missouri: "I judge that one of 3-5 farmers treats wheat for bunt." Maneval.

Kansas: "Not over 1% of the farmers planting wheat treated for bunt." Melchers.

Colorado: "Approximately 20% of the farmers treat wheat for bunt." Leach.

Nevada: "Twenty-five per cent." Lantz.

Idaho: "Seed treatment for bunt almost universal. Copper sulphate common agent." Hungerford.

Washington: "Ninty-nine per cent." Heald and Dana.

California: "Ninty-five per cent or over." Smith.

A special questionnaire was sent to all collaborators asking for data on results with the so-called "dry" formaldehyde method on wheat. Replies were received as follows:

Virginia: "Considerable seed injury reported, due in all cases investigated to failure to follow directions. The most common cause of trouble came from holding grain too long before planting." Fromme.

Arkansas: "Dry formaldehyde failed to control bunt completely and reduced the germination to 25% on the test made by the Plant Pathology Department. The dry treated plat gave 2% bunt against 23% in the check plat." Elliott.

Ohio: "Unfavorable on wheat." Selby.

Michigan: "Satisfactory on wheat." Coons.

Kansas: "The dry formaldehyde method is not advisable for hard winter wheat, since in the preliminary experiments, it did not control the bunt and in all cases where the wheat was kept in storage for any length of time, serious injury resulted." Melchers.

Colorado: "The dry formaldehyde treatment (pint to pint) was ineffective in the control of bunt. Twenty-eight per cent of bunt was developed in the plats treated by the dry method while the standard sprinkling method (1-40) gave 100% control." Leach.

Idaho: "Dry formaldehyde method was used for wheat again this year in treating for bunt. The results were not satisfactory. Two lots of wheat were used which gave 50% and 52% respectively in the checks.

The dry method with no covering afterwards gave 28% and 30% respectively. The same covered five hours gave 10% and 13% respectively. The same covered twenty four hours gave 8% and 18% respectively. Copper sulphate, one pound to five gallons of water dipped for ten minutes gave only a trace in any case whether dipped in lime after or not, and the 1-40 formaldehyde dip method gave a smut-free crop in each case." Hungerford.

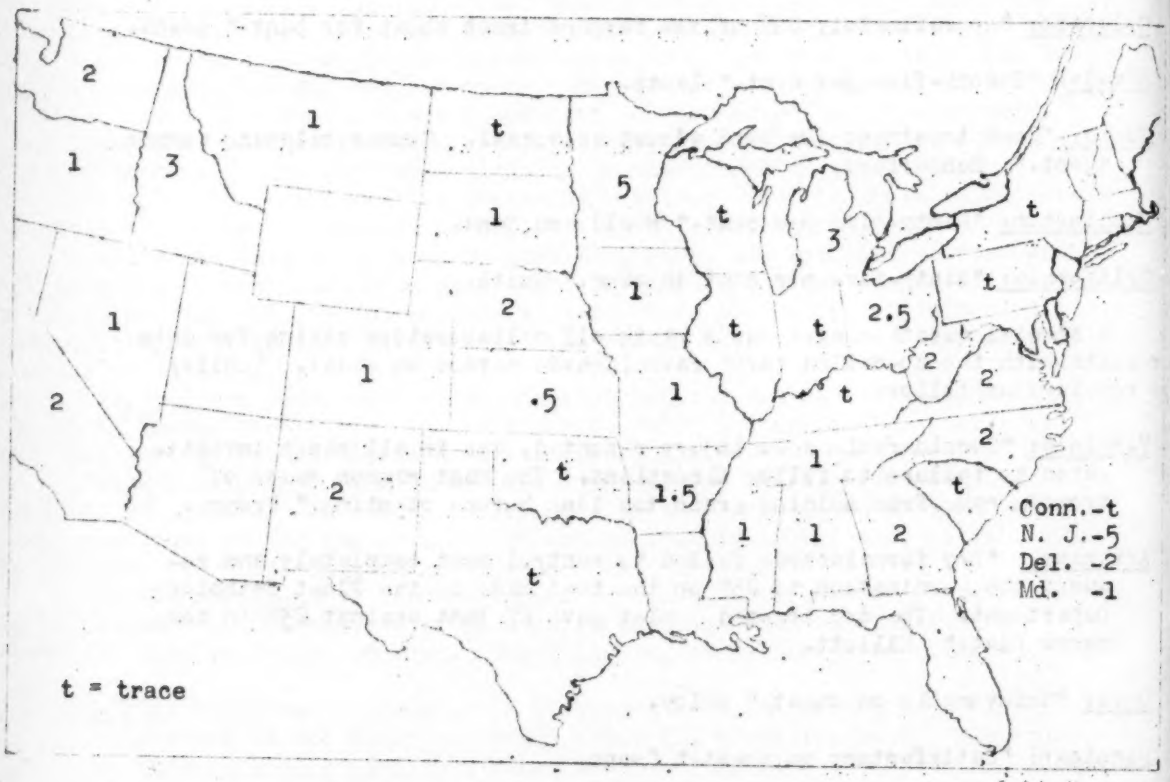


Fig. 3. Estimated percentage reduction in yield from bunt of wheat, 1919.

Loose smut caused by Ustilago tritici (Pers.) Rostr.

The occurrence of loose smut of wheat during 1919 was practically coextensive with the wheat crop and occasioned marked losses in a number of states. In other states the losses it caused were negligible. In general the disease seems to have been somewhat more severe than in 1918.

On the accompanying map are indicated the occurrence and estimated percentages of reduction in yield in the states where losses were reported. It is to be noted that the highest average percentages of loss occurred in the South Atlantic states, especially West Virginia, Virginia, and North and South

Carolina. In Maryland, Georgia, Kansas, Oklahoma, Arkansas, Mississippi, Indiana, Ohio, and Pennsylvania the percentages of loss were considerable; namely; 2-3.5%. The estimated losses from loose smut in 1919 are summarized in bushels in Plant Disease Bulletin, Supplement 12, 1920.

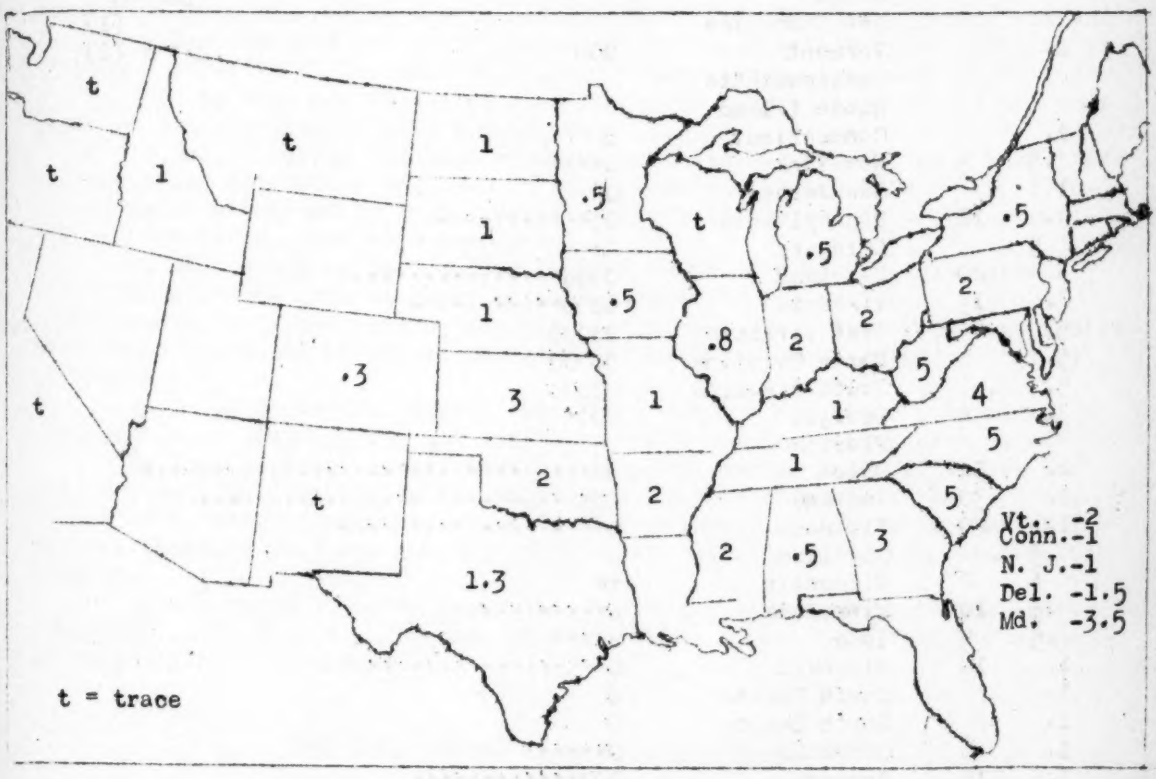


Fig. 4. Estimated percentage reduction in yield from loose smut of wheat, 1919.

In a number of states rather unusually high percentages of loose smut were noted in individual cases as follows: Ohio - 34; Indiana - 30; Maryland, Illinois, and Texas - each 20. The accompanying table and diagram represent the average percentages of loss for each state and the highest percentages as far as reported from any one field. It will be noted that with but few exceptions the states where the highest percentages were reported are not those with the highest average percentages of loss. This would seem to indicate that, from the standpoint of the individual farmer, this disease justifies being watched and fought in the above named states fully as aggressively, if not more so, than in the states where the average percentages of loss for the states are uniformly higher.

On the other hand, there is another factor to consider. Fromme has shown that in Virginia with uniformily infected seed the percentages of loose smut in the crop tends to vary inversely with the fertility of the soil. This may not be without significance in explaining the high average percentages of

Table 6. Losses from Loose Smut of Wheat.- 1919. Table and diagram showing:

(1) the average estimated percentage of loss in each state.
(2) the highest percentage of loss reported from any one field.

(1)	(2)		0 5 10 15 20 25 30 35%
		Maine	Legend
		New Hampshire	0 = (1)
2.		Vermont	00 0+* = (2)
		Massachusetts	
		Rhode Island	
1.		Connecticut	0
.5	5	New York	o****
1.		New Jersey	0
2.	12	Pennsylvania	00**********
1.5		Delaware	0o
3.5	20	Maryland	000o**********
4.	15	Virginia	0000**********
5.		West Virginia	00000
5.		North Carolina	00000
5.		South Carolina	00000
3.	4	Georgia	000*
		Florida	
2.	34	Ohio	00**********
2.	30	Indiana	00**********
1.	20	Illinois	0**********
.5		Michigan	o
t	2	Wisconsin	t*
.5	10	Minnesota	o*********
.5	5	Iowa	o****
1.	18	Missouri	0**********
1.		North Dakota	0
1.		South Dakota	0
1.	6	Nebraska	0*****
3.	15	Kansas	000**********
1.	17	Kentucky	0**********
1.	8	Tennessee	0*******
.5	10	Alabama	o*********
2.		Mississippi	00
		Louisiana	
1.5	20	Texas	0o**********
2.	12	Oklahoma	00**********
2.	6	Arkansas	00****
t	3	Montana	t**
		Wyoming	
.5	4	Colorado	o***
t		New Mexico	t
		Arizona	
		Utah	
		Nevada	
1.	12	Idaho	0**********
t	5	Washington	t****
t		Oregon	t
t	4	California	t***
			0 5 10 15 20 25 30 35%

0 = average percentages; * = highest percentages; o - .5%; t - trace

the South Atlantic states. On this basis the occasionally high percentage in the newer states might be chargeable to unusually heavily infected seed, and possibly to other unknown factors.

No differences as to varietal susceptibility were noted.

As for control measures, the modified hot water method is reported efficient but it is practiced only to a very limited extent. The cereal disease survey men reported having seen wheat fields only in Maryland, Tennessee, and Indiana where the seed had been treated by the modified hot water method. In Indiana forty-five fields were thus noted, in Tennessee two, and Maryland one.

Reports from collaborators also indicated very limited use of the modified hot water method of seed treatment.

In West Virginia Giddings reported as follows: "So far as I know there was never any attempt to use the hot water treatment until this year. I believe that the treatments this year by six farmers, or rather by our department at six farms, were very successful."

In Ohio Selby estimated that 5% of farmers made use of this method.

In Arkansas Elliott reported as follows: "So far as I know the hot water treatment is not used by any of the farmers. The Plant Pathology Department freed the wheat varieties on the Experiment Station from loose smut by this method."

In Idaho Hungerford stated that "Very few use hot water treatment. We are planning a campaign for hot water treatment for seed stock next year."

In Indiana this method, together with the use of seed plots, has been rather extensively tested by the Experiment Station in cooperation with the Office of Cereal Investigations and found practicable. Special equipment for central treating stations has been devised and put into use with satisfactory results.

On the whole it seems clear that the modified hot water method, carefully done, together with the use of seed plots, offers a practicable means of controlling this disease.

Flag smut caused by Urocystis tritici Koern.

Flag smut of wheat, previously known only from India, Eastern Asia, and Australia, was found for the first time in the United States, in Madison County, Illinois, May 5, 1919, as related in U. S. D. A. Farmers' Bulletin 1063 and Plant Disease Bulletin 3:43, 1919. While search was made for this disease in all of the principal wheat growing states by collaborators, cereal disease survey men, and others, it was not found at any other point except in Madison County, Illinois. Altogether the disease was found on twenty farms in the western half of Madison County. The accompanying table gives the different wheat varieties found attacked by flag smut and the number of fields of each.

In each of these fields comparatively low percentages of infection were found; namely, from a trace up to about 2%. As high as 5% was found in limited areas of one field.

No evidence has as yet been adduced as to when or how the disease was introduced into this county. Attempts were made with this in view but no definite information was forthcoming except that in a few cases farmers remember distinctly of having seen the flag smut of wheat in their fields the preceding year. Indications are that the disease has been in Madison County, Illinois for a few years at least.

Table 7. Varieties of wheat infected with flag smut in Madison County, Illinois, in 1919.

Name of variety.	Number of fields infested.
Golden Straw	2
Jones Fife	3
Red Cross (Salzer's Prize Taker)	11
Red May	8
Red Wave	2

With a view of checking the disease the grain from affected fields was given a double strength formaldehyde "dry" treatment after being threshed, and not used for seed purposes. This work was carried out by the Illinois State authorities in cooperation with the Office of Cereal Investigations.

The so-called take-all or foot rot (cause not definitely determined).

A disease of wheat tentatively called take-all, also called foot-rot, was discovered in Illinois and Indiana as related in Plant Disease Bulletin 3:43-46, 1919, and in U. S. Department of Agriculture Farmers' Bulletin 1063. What is possibly the same disease was also reported by Leach from Colorado in a field near Denver, June 2. Somewhat similar troubles, although apparently somewhat different, have been found in Washington and Virginia. Search in other wheat producing states for similar troubles was made by collaborators and cereal disease survey men, but with negative results.

While the losses from the disease were heavy in individual cases, on the whole they were rather slight. In most of the infested fields the affected areas were comparatively small, while in others as high as from 50 to 75% of the acreage was affected. A few very bad fields were plowed up and planted to other crops and more would have been had it not been for the very wet spring season, especially in southern Illinois. The worst affected fields that were left recovered considerably and certain of them yielded about 9 bushels per acre. However, the normal yields should have been 30 to 40 bushels per acre.

In Illinois and Indiana the disease occurred almost entirely in one variety of wheat, namely; that known as Red Cross. In southern Illinois this variety goes most commonly under the name of Salzer's Prize Taker. One field of Fultz wheat, one of Red Chaff wheat, and one of White Clawson were found affected.

Attempts were made to learn how long the disease had occurred in these infested sections and from what source or sources it had been introduced, but very little definite information has as yet been forthcoming. In a few cases it was definitely reported by farmers that they had seen the disease the preceding year.

On the whole, whatever the causes of the disease may prove to be, it seems fairly clear that the combination of conditions brought about by the unusually mild preceding winter probably favored the development of the trouble.

On account of the threatened severity of the disease, precautionary measures were taken in Illinois and Indiana with a view of checking its spread. The grain from infested fields was given a double strength formaldehyde "dry" treatment after being threshed, and not used for seed purposes. This work was carried out by state authorities in cooperation with the Office of Cereal Investigations. Precautions were also taken to prevent the straw from infested fields from becoming a source of further infection. It was either burned or used in paper mills. Threshing machines were also disinfected after threshing the grain from infested fields. The infested fields were to be used for other crops than wheat, barley, and rye for a term of years until it should be found by investigations to be safe to replant to wheat. Later, by special ruling, the planting of oats on infested land was allowed with the understanding that if the disease should develop in the crop the grain would be disinfected and the straw burned or otherwise handled so as to preclude the possibility of spreading the disease.

Stem rust caused by Puccinia graminis Pers.

Stem rust of wheat may be said to have been epidemic during 1919. Its attacks were very severe in a number of important wheat states, especially in the Upper Mississippi Valley. The disease started rather early in this region and, favored by the weather, spread rapidly, involving the northern portion of the winter wheat states and the entire spring wheat area in an outbreak such as had not been experienced since the epidemic of 1916. The accompanying map shows the distribution of losses by states and estimated percentages of reduction in yield for stem rust in 1919. The complete data on losses are given in tabular form in Plant Disease Bulletin, Supplement 12, 1920.

The following report from North Dakota by Professor Bolley is of especial interest.

> "Stem rust (Puccinia graminis) was very destructive throughout the eastern portion of the state from the Red River Valley to the Missouri and came in the form of general epidemic infection. It could not be looked upon, as in some years, as due to a local infection but swept over the border uniformily along the entire eastern and southern front. The first date of infection on bushes of barberry was located at Walcott, Richland County, April 28th. The first infection on wheat itself in the red stage is recorded for the region of Fargo on date of June 23rd and quite generally distributed June 25th.
>
> "The destruction wrought by rust this year was even more severe and extended than in the great rust epidemic year of 1916. Associated as it was with peculiar weather conditions giving a good infection period just at the right time, followed by intense drought and hot winds just after the out-break of the rust, a reduction of yield which is enormous was brought about. The wheat rust and scab alone under these conditions resulted in from probably 40 to 60% of the possible normal crop. In this connection it must be remembered that the entire damage done cannot be assigned to any one cause. Rust should not be given credit for the entire destruction for we have long since learned that a heavy infection of rust and a heavy breaking out of stem rust can occur without shrivelling, if weather

conditions are correct and no other imperfect fungi are attacking. However, scab and other imperfect fungi develop profusely under essentially the same conditions which facilitate the development of rust. When the stem is mutilated or injured by the rust pustules, fusarial fungi and other stem parasitic and saprophytic forms readily destroy the straw structure."

The greatest losses occurred in the barberry eradication area. This is at least partly chargeable to the fact that the barberries were not all out. Severe attacks of the rust also occurred in West Virginia in many sections of which state numerous barberries were found along fences and roadsides growing wild. This was especially true in Monroe County.

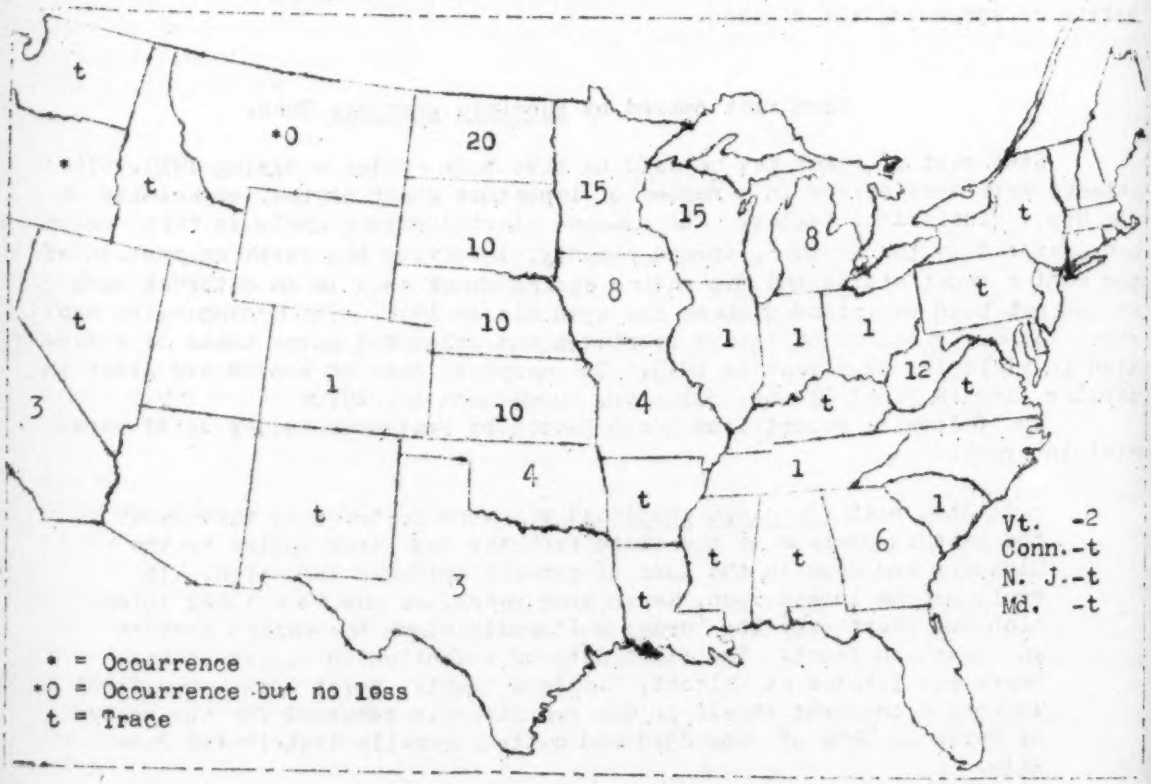


Fig. 5. Estimated percentage reduction in yield from stem rust of wheat, 1919.

While the barberry eradication campaign was pressed vigorously in most states of the barberry eradication area, numerous infected barberries, both cultivated and escaped, were found widely scattered in a number of states. As in the preceding year, a number of cases were noted, especially in the northern states, where infected barberries were clearly the centers of infection from which the rust had started in the spring. In a limited number of cases early infections, especially on certain grasses, and later on wheat or other grains,

were noted at considerable distances from infected barberries. This seems to indicate that, under the conditions of the unusually mild preceding winter there may have been at least a certain amount of overwintering on grasses even as far north as Wisconsin. This, especially in the northern states, is in rather sharp contrast with indications the preceding season which was preceded by a rather severe winter. At that time, there was scarcely any indication of overwintering on grasses, especially in the north. The Office of Cereal Investigations continued their special study of this phase of the problem in 1919 and the detailed results will be summarized by that Office and published later.

The barberry clearly seems to be the most important source of early spring infections, at least in the spring wheat states. Especially is it a factor in starting the rust early and it is these early infections that may play a very important part in initiating epidemics.

As to rust resistant varieties of wheat, Kanred selections are reported as showing resistance in Kansas and Oklahoma, and Acme and North Dakota D 5 are similarly reported from North and South Dakota, and Mindum, a durum wheat, is practically immune in Minnesota. Regarding the resistance of this variety, E. C. Stakman reported:

> "Mr. P. J. Olson, who was formerly in the Agronomy Department of the University and is now operating a farm at Grafton, Minnesota, said that his Marquis yielded less than half a crop and was very severely rusted. He had a few acres of Mindum growing along side the Marquis and it was scarcely possible to find a trace in the field. The yield was between 20 and 25 bushels per acre. It had escaped rust damage entirely."

A special questionnaire was sent to collaborators asking about progress made in barberry eradication and results. Replies were received as follows:

Virginia: "None undertaken." Fromme.

West Virginia: "There has been practically no effort to eradicate the barberry." Giddings.

Tennessee: "The common barberry is not native in Tennessee. No effort has been made to eradicate the few hedges in the state. There is no evidence that the barberry is a factor in the wheat stem rust situation in this part of the country." Essary.

Arkansas: "No barberries in this state that I know of." Elliott.

Ohio: "Work not done through this office during 1919, but results reported by Prof. W. G. Stover quite satisfactory. Ruling entered December 20, through formal notice of hearing by Secretary Board of Agriculture, requiring removal of all forms of Berberis vulgaris and varieties, from nursery plantations in Ohio." Selby.

Michigan: "The following statistics from the Barberry Campaign reveal an almost unbelievable number of barberries which have been found by federal field agents working in cooperation with the college. It is noteworthy that at least fifteen areas where the barberries had escaped to woods and waste lands have been found.

The barberry menace has been attacked not a bit too soon. The figures are as follows:

New Barberry Location for 1919 - (Up to Sept. 1.)

No. of counties surveyed	51
No. of locations in towns and cities	656
No. of locations in country about residences	581
No. of locations in fields, woods, and roadsides	82
Total locations found	1319
In terms of bushes found:	
No. of bushes found in towns and cities	4301
Of these, the following were infected with black stem rust of grains	3174
No. of bushes found in country about residences	7540
Of these, the following were infected with black stem rust of grains	5876
No. of bushes found wild	3298
Total bushes found	15139"

Minnesota: "55,441 bushes of common barberry were located in 70 counties; of these 35,788 bushes carried rust infections. 13,918 bushes were located in towns; 41,523 bushes were located on 326 farms in 53 counties. Of these 36,685 bushes were growing wild in 25 counties. 50,541 bushes have been completely removed - 4,900 remain to be destroyed. These will be removed before the infection period next year." Bisby.

Missouri: "No eradication work on barberry has been done in this state. The barberry seems to be rather unimportant as far as stem rust is concerned." Maneval.

Kansas: "Kansas has not entered the barberry eradication campaign." Melchers.

Colorado: "The final figures from the campaign against the common barberry in Colorado during the year 1919 show that there were approximately 17,677 of these bushes in the state. The scouts inspected the properties of nearly every town in the state. A large percentage of the rural districts were also scouted by means of automobiles. The 17,677 bushes found were located on 1,502 properties. Each of these properties were revisited to make sure that the bushes were removed. The educational phase of the program was pushed with especial emphasis. The workers did all that they could to inform the public of this pest and how it worked. Talks were given in nearly every grade in every school in the state, in town halls and in public gatherings of all kinds. Newspaper articles were published in all papers, ranging from the dailies of the cities to the tri-monthly edition of the rural districts. The moving picture houses donated their services in showing explanatory slides before their patrons. The animated cartoon supplied by the United States of Agriculture was used to much advantage. In fact, every method practicable was used in disseminating information. The

campaign will be continued during the winter and again next spring. The winter program will consist of continued educational work, specimens of infected barberry, infected wheat and Japanese barberry, with explanatory material, are to be sent to every school and school teacher in the state. These specimens are to be prepared in such a form that they may be hung in a conspicuous place. As a whole, the barberry campaign has been very successful." Leach.

Idaho: "Accurate information not available." Hungerford.

Washington: "Barberry eradication not recommended for Washington." Heald.

California: "The barberry is not a factor in rust eradication in the state." Smith.

This rust was reported also on spelt in Minnesota.

Leaf rust caused by Puccinia triticina Erik.

During the past year the leaf rust of wheat was unusually severe. It varied in destructiveness from nothing to total loss of the crop, with various gradations between. In individual cases, especially in Georgia and Arkansas, certain fields of winter wheat were so severely attacked by leaf rust that they were abandoned in the spring of 1919, plowed up and planted to other crops. Never before in this country have so severe injuries from this disease been recorded. The severity of the attacks were apparently accentuated, especially in the southeastern states, by the fact that tht winter was very mild. The rust was able to obtain a good start in the fall and propagated late into the winter and again in early spring. In this way it caused severe injury when the wheat was unable to keep pace with it or keep sufficiently ahead. Hence the losses caused by leaf rust in the southern states were considerable. Farther north the wheat was, as usual, better able to withstand the attacks of leaf rust, but on the whole no doubt suffered somewhat from the rather heavy attacks. In Virginia it was especially severe east of the Blue Ridge Mountains, where it caused marked losses. In Pennsylvania infection was especially severe in the southeastern part of the state. The rust attacks were less severe in the more mountainous sections. In the far northwest and western states no appreciable injury was reported except in a few cases, especially in Montana where rather severe attacks were noted locally in certain irrigated sections.

The accompanying map shows the estimated percentages of reduction in yield in the various states caused by leaf rust in 1919. These data together with the corresponding losses in bushels computed from estimated productions are given in tabular form in Plant Disease Bulletin, Supplement 12, 1920.

Certain variations in varietal susceptibility were noted both by the cereal disease survey scouts and by certain collaborators. In general practically all wheat varieties are highly susceptible. It was, however, noted both in Kansas and Tennessee that the Kanred selections, especially P 1066 and P1068, showed marked resistance. In North Dakota it was noted that certain durum wheat selections, especially North Dakota D 1 and D 5, showed resistance

to leaf rust. It was also noted in the Alabama Experiment Station wheat variety test plots that a durum wheat showed resistance to leaf rust. In Arkansas it was noted that the earlier varieties escaped to some extent. This rust was reported also on spelt from Indiana and Minnesota, and on rivet, emmer, and einkorn from Indiana.

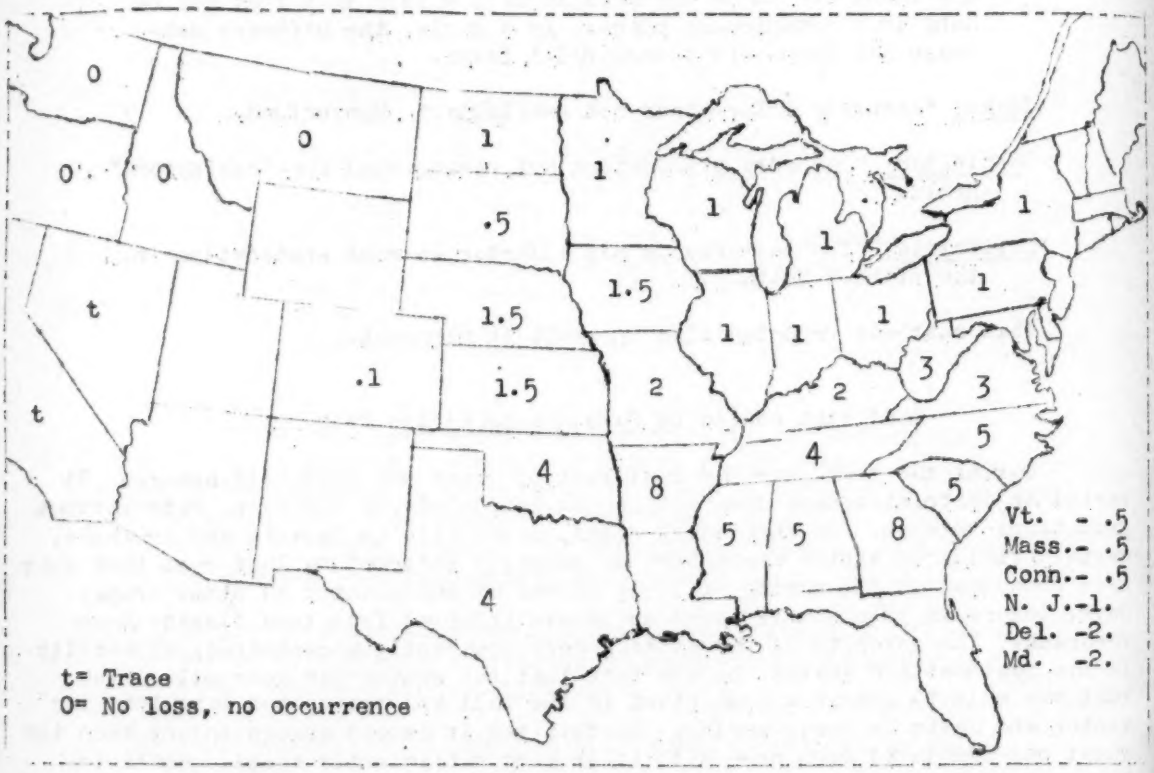


Fig. 6. Estimated percentage reduction in yield from leaf rust of wheat, 1919.

H. S. Jackson, who is making a special study of this rust at the Indiana Agricultural Experiment Station in cooperation with the Office of Cereal Investigations, United States Department of Agriculture, has kindly furnished the following summary of the season's work bearing on varietal susceptibility.

"We grew ten varieties of durum wheat. All showed marked resistance to the leaf rust. One variety of Polish wheat showed but slight infection. Six varieties of emmer which were grown here showed considerable resistance. A variety of einkorn only slight flecking. Four varieties of rivet and spelt showed a somewhat higher degree of susceptibility than the durums but were not as susceptible as most of the common wheats. Fourteen varieties of club wheats also showed heavy infection. Of about two hundred varieties, selections and hybrids of the common wheats, only about fifteen selections of four hybrids showed any resistance. All those showing any degree of resistance were of the Crimean group.

"In general then, the durums, emmers, Polish, and einkorns showed considerable resistance. The rivets and spelts were intermediate and except for a few varieties the common wheats showed considerable susceptibility. The club wheats were all very susceptible."

Stripe rust caused by Puccinia glumarum (Schm.) E. & H.

Stripe rust was reported on wheat in 1919 from Idaho, California, Oregon, and Washington.

In Idaho C. W. Hungerford reported the rust as not common, but reported its occurrence on wheat from the following counties: Bonner, Latah, Nez Perce, Lewis, Idaho, Washington, Fremont, Jefferson, and Madison.

In Oregon the following report from C. E. Owens summarizes the situation including the occurrence of the rust on wild grasses: "Occurs on susceptible varieties of wheat such as Little Club, Jones Winter Fife, and slightly on Turkey Red. Absence of rust on wheat growing in close proximity to infested grasses in some localities due to fact that wheat happens to be resistant variety. Very severe outbreak on susceptible varieties of wheat on Experiment Station grounds at Moro, Oregon.

"Stripe rust is abundant on grasses, especially Elymus, throughout territory west of Cascades, and in Sherman County on Agropyron. Has been reported as far east as Union County."

In Washington Heald and Dana reported the rust as occurring in slight amounts in Whitman and Spokane Counties.

Scab (blight) caused by Gibberella saubinettii (Mont.) Sacc.

Wheat scab (blight) was unusually severe in 1919, especially on the wheat heads and caused enormous losses in the Upper Mississippi Valley and eastward. The seedling blight was also reported from Minnesota, Wisconsin, Illinois, and Indiana. The seedling blight was particularly severe in Minnesota where it is reported as follows: "The seedling blight disease was very prevalent in the Red River Valley and some other parts of the state in the latter part of May and early June. The wheat scab organism was isolated from many of the diseased seedlings, particularly the macaroni wheats, though Helminthosporium was often present also. The disease often appeared in spots causing a complete failure in the diseased area. Many fields were plowed and planted to flax." (Division of Plant Pathology.)

By far the greatest losses from the head blight occurred in Iowa, Illinois, and Indiana. Very heavy losses occurred also in Ohio, West Virginia, Kentucky, Tennessee, Wisconsin, Missouri, Minnesota, North and South Dakota. In a number of other states the losses while great, were, in general, considerably less. In other states there was no loss or it was negligible. From some states no reports were received.

The unusual severity of wheat scab was emphasized by collaborators in a number of states as follows:

Iowa: "Very common throughout the state. Most destructive disease of wheat in state." A. L. Bakke.

"Scab in Marquis has developed to a serious degree." I. E. Melhus. "Much damage reported, especially in the southeastern section, due to scab." I. E. Melhus.

Illinois: (July 2) "Particularly serious this season; in many fields will cut the yield more than 50%. The disease has been reported very generally all over the state. Some county agents have estimated that from one-half to three-quarters of the crop is infected. It has developed very rapidly during the past week or ten days and the loss will be much greater than was anticipated a week ago." W. L. Burlison and G. H. Dungan.

Indiana: "Wheat scab is the most serious wheat disease in Indiana and has been reported from all parts of the state. Infection varied from 0 to 100% and the yield was greatly reduced in many cases. This disease is illiciting inquiries from a large number of growers." M. W. Gardner.

Ohio: "Generally severe, especially in western and northern Ohio and where wheat followed corn. Maximum per cent of head attack 80%. Low percentages in southeast. Estimated maximum loss in yield scarcely exceeds 33%." A. D. Selby.

Tennessee: "Heaviest damage known. Serious damage. Loss estimated 10 to 90%." S. H. Essary.

West Virginia: (July 1) "This, I believe, is the most serious disease of wheat in West Virginia. Last year it was very prevalent and the wheat was refused at some mills on account of the scab infected grain. This year it is quite generally reported and is likely to be as destructive as it was last year." N. J. Giddings.

Minnesota: "One of the worst diseases of wheat this year was, by all odds, scab. It is infinitely worse than it has been since 1916, and especially in the southern third of the state. It is remarkable, that it became less severe in traveling north through the wheat region." (August) E. C. Stakman.

North Dakota: "Scab caused great damage in Marquis, Fife, Blue Stem, and most species of durum throughout the state. It was destructive at all stages, particularly on old crop lands under constant cultivation and often on new lands where scabby seed was used." H. L. Bolley.

Numerous cases were observed and many others reported, particularly in Illinois, where scab (blight) was so severe on Marquis wheat that large fields were left unharvested. Others were harvested, at least in part, and when threshed yielded as low as five and six bushels to the acre where thirty-five or forty bushels per acre were expected before the disease developed.

Particularly in southeastern South Dakota, southern Minnesota, southern Wisconsin, Iowa, Illinois, Indiana, Kentucky, and Tennessee wheat scab (blight) was, by all odds, the most important factor in the shrinkage of yields and lowering of quality of wheat in 1919. In these states alone there was, according to estimates made by the Bureau of Crop Estimates, a total shrinkage of 88,509,000 bushels of all wheat from the June 1 forecast. The following table shows this more in detail and just where the greatest losses occurred.

Table 8. Forecast and production of wheat in certain states in 1919.

States	Forecast June 1 from condition		Production Recorded December		Shrinkage from forecast.					
	Winter (000 omitted) bushels	Spring (000 omitted) bushels	Winter (000 omitted) bushels	Spring (000 omitted) bushels	Winter (000 omitted) %	Winter (000 omitted) bushels	Spring (000 omitted) %	Spring (000 omitted) bushels	Total (000 omitted) %	Total (000 omitted) bushels
South Dakota	1,957	48,684	975	29,200	50	982	40	19,484	40	20,466
Minnesota	1,486	61,451	975	36,735	34	511	40	24,716	40	25,227
Wisconsin	2,326	8,691	1,490	5,865	36	836	33	2,826	33	3,662
Iowa	18,119	11,053	16,530	7,145	9	1,589	35	3,908	19	5,497
Illinois	67,985	15,675	57,800	7,875	15	10,185	50	7,800	21	17,985
Indiana	56,656	822	45,792	228	19	10,864	72	594	20	11,458
Kentucky	14,707		12,029		18	2,678			18	2,678
Tennessee	8,826		7,290		17	1,536			17	1,536
Total	172,062	146,376	142,881	87,048		29,181		59,328		88,509
Total all wheat (000 included)	318,438,000 bu.		229,929,000 bu.					88,509,000 bu.		

While in this group of states stem rust was responsible for considerable of the shrinkage from the June 1 forecast in South Dakota, Minnesota, and Wisconsin, scab was the one big factor in the other states named; that is, in Iowa, Illinois, Indiana, Kentucky, and Tennessee. The heavy losses from scab in South Dakota, Minnesota, and Wisconsin were largely confined to the southern parts of those states.

Special studies were made of various phases of the wheat scab problem by the Office of Cereal Investigations. These investigations were conducted especially in Wisconsin, Minnesota, Nebraska, Iowa, Illinois, Indiana, Ohio, Kentucky, and Tennessee. In connection with this work in each of thest states carefully made estimates as to severity of scab were made. The data thus obtained supplement those obtained by the general cereal disease survey men and collaborators. On the basis of all these data and information on the varying crop conditions, careful estimates of percentages of reduction in yield in the various states due to scab have been arrived at as indicated on the accompanying map. The estimated losses summarized in bushels are given in Plant Disease Bulletin, Supplement 12, 1920.

In connection with the different surveys, the Office of Cereal Investigations made a special study of the different species of Fusarium and Gibberella associated with wheat scab in the different states in 1919. The following is a brief summary of the results: "A careful study of over one thousand specimens collected in fifteen states showed Gibberella saubinettii (Mont.) Sacc. to be the chief causal organism. Less than 1% of the specimens yielded Fusarium culmorum (W. Sm.) Sacc., F. avenaceum (Fr.) Sacc., and other Fusarium species."

From an analysis of the data obtained from the various sources it is evident that a number of inter-related factors were concerned in bringing on this wheat scab epidemic in 1919, such as (1) the abundant presence of the parasite in close proximity to the wheat, (2) favorably moist and warm weather conditions after wheat had headed, and (3) the presence of especially susceptible spring wheat in considerable abundance farther south than usual.

The extensive field observations showed that the parasite (G. saubinettii) was present in sporulating condition in and near wheat fields on a number of organic substrata, particularly old infested crop refuse on the surface of the soil such as corn stalks, old straw, and stubble of various grains and grasses.

In a number of cases in various states it was noticed that wheat scab was more severe where corn had been the preceding crop than otherwise. In other cases it was reported that equally as much scab occurred when the preceding crop had been wheat. In still other cases, observed especially later in the season, indications seemed to be that the air was so filled with spores of the parasitie that very heavy scab infections resulted regardless of the preceding crop. In some cases also scab infections were found heaviest near the edges of fields and near old straw stacks. Such infections seemed to be traceable to the abundance of the parasite on grass straw and stubble in the fence rows, and on the old straw at the bases of the straw stacks.

As bearing on the relative amounts of wheat scab where corn had been the preceding crop and not, a special questionnaire was sent to collaborators asking for "evidence showing relation between corn root and ear rots and wheat scab." While most collaborators reported no data, others reported as follows:

Pennsylvania: "In fields which followed corn the infection is about 10% on the average, and where corn was not the previous crop the infection is about 3 to 4%." C. R. Orton.

Virginia: "Worse following corn. The following data was obtained in Pulaski County by A. B. Massey on June 20. All percentages are based on counts of heads:

Farm No. 1. 20 acre field all seeded at same time with same seed, but parts had different treatment.

North end. No corn 1918, nor manure... ..... 10% scab
Middle, No corn 1918, manure mixed with corn stalks applied..... 20-40% "
South end. Corn 1918..... 50% "
Farm No. 2.
Field A. 11 acres, 1917 grass, 1918 corn, 1919 wheat 50% scab
Field B. 7 acres, 1917 grass, 1918 wheat, 1919 wheat 2% " "

F. D. Fromme.

Georgia: "More noticeable when wheat follows corn." Berry.

Tennessee: "Evidence showing relation of corn root rot and wheat scab is very strong. Wherever the two crops follow each other, the diseases are always severe. We have little doubt of the relation." Essary.

Ohio: "Did not collect special memoranda. Found many cases of evidence of larger amounts of scab on wheat about areas of upturned corn roots." Selby.

Missouri: "There is some evidence that scab of wheat is worse where wheat follows corn than in other rotation." Maneval.

Minnesota: "The following are the results obtained this year on the effect of rotation on the percentage of scab:

Preceding crop	No. fields visited	Average percentage of disease	Yield in bushels.
Corn	193	23.53	5.62
Wheat	95	7.42	11.23
Oats	67	10.81	10.03
Barley	20	11.15	10.75

Kansas: "We have no evidence to show any relation between corn root rot and wheat scab. Corn root rot is present in this state this year, a small amount of scab was found in some localities. Most generally scab is not present in Kansas." Melchers.

As to the relative importance of the different kinds of old crop refuse on the surface of the soil, old corn stalks seem to be the most important as a substratum for the parasite, this no doubt because the fungus is able to grow in greater abundance on them because of their large size and general

suitability when climatic conditions are favorable. Old straw and stubbles of wheat, oats, and barley, when not properly covered, also were important substrata for the parasite, as were straw and stubble of wild grasses in nearby fence rows and at edges of fields. There is no evidence at hand to show that the refuse from dicotyledonous crops or weeds furnished substrata for the parasite.

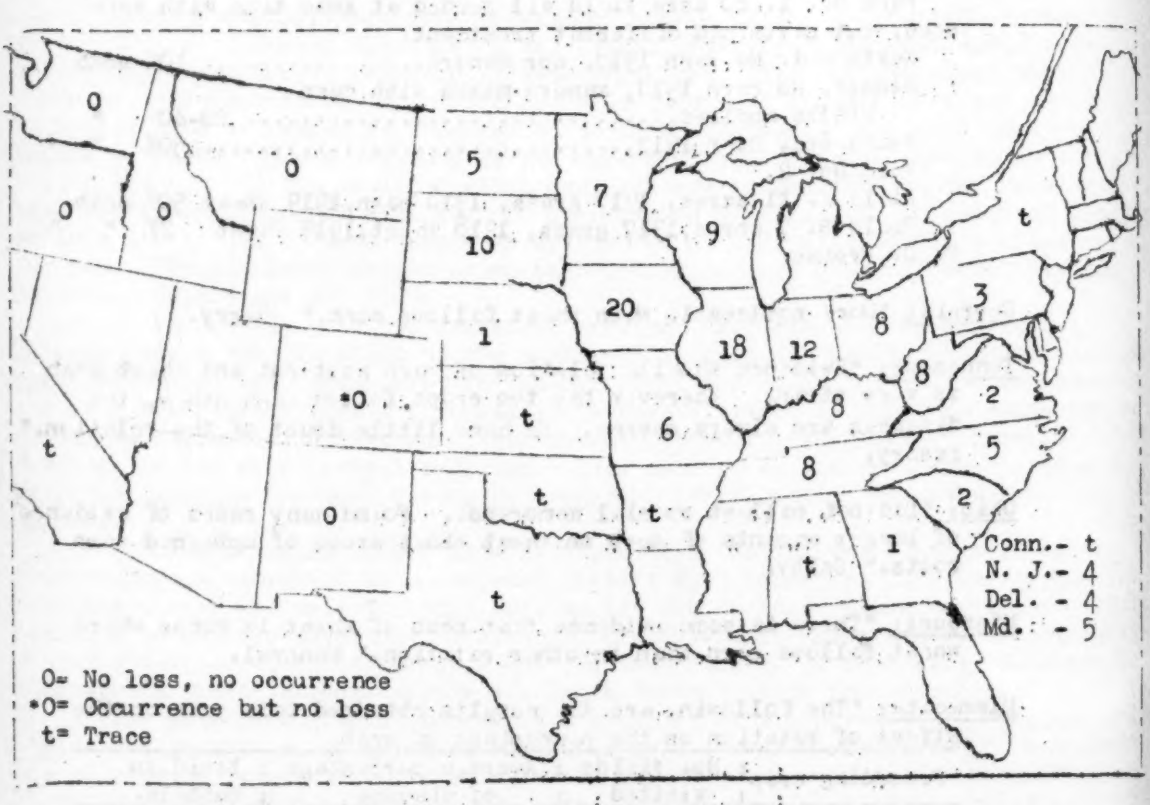


Fig. 7. Estimated percentage reduction in yield from scab of wheat, 1919.

Hence the abundant presence of the wheat scab organisms (G. saubinettii and Fusarium spp.) in sporulating condition on various substrata, in close proximity to the wheat following the blossoming period together with moist, warm weather at that time, favorable for spore dissemination and infection seem to have been the chief factors in bringing on the wheat scab epidemic in 1919. This disease was reported also on spelt from Minnesota.

As to relative susceptibility of varieties, definite data are very meagre. The following reports bearing on this were received:

South Dakota: "Marquis susceptible; Preston and Blue Stem only slightly better. Kubanka and Acme were resistant but "dodged" some of the scab due to different heading time." Manley Champlin.
"Usually durum wheats scab worse than Marquis. This year the reverse was true." Champlin.

Minnesota: "Marquis is most susceptible, though considerable is reported on Velvet Chaff and Blue Stem. Neighboring fields of Marquis and Velvet Chaff showed 100% and 15% infections respectively. Many of the varieties on University Farm are found susceptible." Section of Plant Pathology.

West Virginia: "Bearded varieties affected most severely." Giddings.

Maryland: "No particular variety was noticed as especially susceptible or resistant." Temple.

No successful control measures are reported.
This disease was reported also on spelt from Minnesota.

Nematode disease caused by Tylenchus tritici (Stein) Bast.

Special efforts were made to determine the geographic occurrence of the nematode disease of wheat in 1919. In addition to data gathered by the cereal disease survey men and collaborators, a special nematode disease survey was made in cooperation with the state authorities of Georgia, Maryland, Virginia, and West Virginia. Practically all inspections were made on the threshed wheat, hence the percentages given indicate proportions of nematode galls in grain.

In Georgia 35 communities in 19 counties in the northern part of the state were visited. Fortunately the disease was found only in the one county, Jackson County, where it was known to have occurred the preceding year. A special farm-to-farm survey was made in the infested portion of Jackson County and only 14 farms were found where the nematode disease could be located. On one of these farms a 50% infection was found. On the other infested farms the percentages of infection were comparatively low.

In Maryland 71 towns in 15 counties, covering the principal wheat growing sections, were visited without finding even a trace of nematode disease infection in wheat. Both Allegany and Montgomery Counties, where the disease was found the preceding year, were visited but with negative results. Of course this does not necessarily mean that the disease was absent. It simply means that the disease, if present, is not severe. The grain from a few infested farms might very easily not have been going through the elevators and mills when inspections were made in 1919.

In Virginia 357 towns in 72 counties were visited by cereal disease survey men and collaborators. The men visited mills, elevators, and farms. The nematode disease was found in 43 counties. In 29 counties either the disease was not found or was found in wheat brought in from some other county. The following table summarizes the data at hand by counties. In this table the following terms are used in general to represent conditions as follows:

Local = 1-20% presence; Scattered = 20-40% presence; Rather general = 40-60% presence; General = 60-80% presence; Very general = 80-100% presence. Very slight = Trace; Slight = About 1%; Rather severe = About 2%; Severe = About 3-4%; Very severe = 5% and above.

Table 9. Summary of data on the occurrence of the nematode disease of wheat in Virginia.

Counties	Infection			
	Severity in 1919			Number of records in previous years.
	General condition	Range	Number positive cases	
Albemarle	Very general, rather severe	Trace-30%	84	21
Alexandria	No data	No data		1
Alleghany	Local, very slight	Trace	1	0
Amelia	Local, very slight	Trace	2	1
Amherst	Local, very slight	Trace	1	0
Augusta	Rather general, moderate, occasionally severe	Trace-20%	14	10
Bath	Local, very slight	Trace	1	1
Bedford	Local, very slight	Trace-.5%	5	0
Botetourt	None found		0	
Brunswick	None found		0	
Campbell	Local, very slight	Trace- 1%	7	1
Caroline	None found		0	1
Carroll	Local, very slight	Trace	1	0
Charles City	Local, very slight		1	0
Chesterfield	None found		0	
Clarke	Local, very slight	Trace	1	2
Culpeper	None found		0	2
Cumberland	None found		0	
Dinwiddie	Local, very slight	Trace- 3%	2	0
Fairfax	Rather general, moderate, occasionally severe	Trace-10%	5	1
Fauquier	Rather general, moderate	Trace-5%	8	11
Fluvanna	Very general, severe	Trace-30%	22	2
Franklin	Local, very slight	Trace	1	2
Frederick	Local, very slight	Trace	2	2
Giles	None found		0	
Goochland	None found		0	
Greene	Local, very slight	Trace	1	0
Greensville	None found		0	1
Halifax	None found		0	
Hanover	Local, very slight	Trace	1	0
Henrico	None found		0	
Henry	Local, very slight	Trace-1%	3	0
Highland	None found		0	
James City	None found		0	
King George	None found		0	
King and Queen	Scattered, moderate, occasionally severe	Trace-10%	3	1
King William	Local, very slight	Trace	1	0
Lee	None found		0	

Counties	Infection			
	Severity in 1919			Number of records in previous years
	General condition	Range	Number positive cases	
Loudoun	General, moderate, occasionally severe	Trace-25%	14	3
Louisa	Scattered, very slight	Trace	2	2
Lunenburg	Local, slight, occasionally severe	Trace-7%	2	1
Mecklenburg	Local, very slight	1%	1	0
Montgomery	Local, slight	Trace-3%	5	11
Nelson	Rather general, slight, occasionally severe	Trace 30%	6	0
Northumberland	None found		0	
Nottoway	None found		0	1
Orange	Scattered, slight, occasionally severe	Trace-30%	4	0
Page	Scattered, very slight	Trace	2	4
Patrick	None found		0	
Pittsylvania	Rather general, slight	Trace-2%	7	0
Powhatan	Local, very slight	Trace	3	1
Prince Edward	None found		0	
Prince George	None found		0	
Prince William	Local, slight	Trace-1%	3	1
Pulaski	Local, very slight	Trace	2	0
Rappahannock	None found		0	
Richmond	Local, very slight	Trace	1	0
Roanoke	None found ?		0 ?	
Rockbridge	Local, very slight	Trace	1	6
Rockingham	Very general, very severe	Trace-70%	76	70
Russell	None found		0	
Shenandoah	Rather general, severe	Trace-30%	12	11
Smyth	None found		0	
Southampton	None found		0	
Spotsylvania	Scattered, very slight	Trace	3	2
Stafford	Scattered, slight	Trace	3	6
Surray	None found		0	
Sussex	None found		0	
Tazewell	Local, very slight	Trace	1	0
Warren	Local, very slight	Trace	1	0
Washington.	Local, very slight	Trace	1	0
Westmoreland	Local, very slight	Trace-2%	1	0
Wise	None found		0	
Wythe	Rather general, slight	Trace-2%	7	6

The summaries of data in the preceding table are largely taken over from a similar table prepared by F. D. Fromme in his report on the 1919 cooperative nematode disease survey in Virginia. In this report Fromme comments on the general situation in Virginia as follows:

> "The disease is now known to occur to some extent in all sections of the state. It is most general and severe, as previously noted, in the Valley and Piedmont sections, especially in the counties of Rockingham, Shenandoah, Augusta, Albemarle, Fluvanna, Fauquier, Loudoun, and Stafford. The only counties in southwestern Virginia that show any appreciable amount of the disease are Montgomery and Wythe.
>
> "There is considerable evidence to show that the disease has been introduced rather recently into the lightly infested counties from counties where infection is general and of long standing. For example, most of the known cases in Pittsylvania County have been traced to a single purchase of wheat from the Valley. In these lightly infested counties the disease occurs in localities, having been introduced by a farmer who later sold seed to his neighbors.
>
> "It seems important in connection with efforts to reduce the amount of disease in the more generally infested counties that steps should be taken to prevent further introduction of the pest into the lightly infested counties. This may be accomplished in part by educational work, but to be fully effective should, in my opinion, be backed by restrictive measures.
>
> "The nematode disease is now known to occur in over half of the counties of the state. It is quite probable that it occurs to some extent in a number of the remaining counties. At any rate it seems only a question of time, under the present unrestricted movement of wheat, until it shall become established in all counties."

In West Virginia 36 towns and 17 counties were visited by the cereal disease survey men and collaborators, and the disease is reliably reported from two additional counties. The counties inspected were, first, those along the Virginia border from some of which the disease was reported the preceding year, and second, a number of counties in the Ohio River Valley, the principal wheat growing section of the state. Altogether the disease was found in four counties from which it had not been previously reported. All of these are on or near the Virginia border. No infections were found in the Ohio River Valley.

In Table 10 is summarized the data at hand for the counties from which reliable data is available. The same usage of terms is followed as for Virginia.

The most severe infections seem to be in Pendleton and Hardy Counties. This is as might be expected since these counties join two of the most heavily infested counties in Virginia, namely; Rockingham and Shenandoah. While most of the seed wheat is home grown in these counties, it was definitely learned in one case, where a farmer's wheat was found infected, that he had purchased the seed across the state line in Shenandoah County, Virginia. After the disease is introduced in a community it gradually spreads.

It is of especial interest also to note that a certain milling firm in Hardy County reported that the disease has been present there for about fifteen years; some years as much as a peck of nematode galls per bushel of wheat had been found.

The suspicious report regarding the occurrence of the disease in North Carolina, mentioned in Plant Disease Bulletin, Supplement 4: 134, 1919, has not been followed up as yet. Two incidental inspections were made at Garysburg, Northampton County, North Carolina, with negative results.

Table 10. Summary of data on the occurrence of the nematode disease of wheat in West Virginia.

Counties	Infection			
	Severity in 1919			Previously recorded
	General condition	Range	Number of positive cases	
Berkeley	None found			
Cabell	None found			
Grant	Local, rather severe	3	1	+
Greenbrier	Scattered, slight	Trace-1%	6	+
Hampshire	Local, slight	Trace-2%	1	
Hardy	General, severe	Trace-5%	4	+
Jackson	None found			
Jefferson	Local, very slight	Trace	1	+
Marshall	None found			
Mercer	Scattered, slight	Trace	3	
Mineral	Rather general	Trace-2%	3	
Monroe	Present. No data as to severity			+
Morgan	None found			
Nicholas	Present. No data as to severity			
Pendleton	Present. No data as to severity			+
Ohio	None found			
Pleasant	None found			
Summers	Scattered, very slight	Trace	3	
Wood	None found			

An incidental inspection was also made at Delta, York County, Pennsylvania, with negative results.

In Ohio, inspections were made at two mills in Gallipolis, Gallia County, and wheat nematode galls were found in wheat screenings at both places. In both cases the millers stated that the wheat from which the infected screenings had been removed was Ohio wheat, although considerable wheat from West Virginia is also marketed there. The evidence, therefore, as far as it goes, indicates strongly that the disease is becoming established in southern Ohio. Unfortunately, the discovery of this infection in Ohio was made just at the close of the nematode disease survey, so that it was impossible to follow up the matter farther at that time, much as it deserved to be.

In addition to the surveys in the eastern states, as mentioned above, L. P. Byars, of the Office of Cotton, Truck and Forage Crop Disease Investigations, in cooperation with the Office of Cereal Investigations, made a special survey for the disease in the central and western states in the summer of 1919, with negative results throughout. It is of especial interest to note that the

disease did not perpetuate itself in California where it occurred in 1917. As bearing on this, W. W. Mackie reported that the field at Red Bluff, California, where the disease had occurred in 1917, was left unplowed and allowed to grow up to volunteer wheat in 1918; hence ideal conditions for reinfection if such were possible. Professor Mackie inspected this volunteer wheat himself July 1918, but found no nematode infection whatever there. It was thought that the seed for the preceding crop, in which the disease had occurred, had been imported, but definite information was not obtainable as to the source. Indications are, therefore, that the very dry, hot summer conditions common to the Red Bluff section of California, proved too severe for the parasite. The whole situation, however, suggests that there may possibly be some place on the Pacific Coast where the disease is occurring. That is, the place from which the infested seed, referred to above came.

The estimated percentage of loss for Virginia and West Virginia is about 5%. These losses summarized in bushels are given in Plant Disease Bulletin, Supplement 12, 1920.

While as yet the actual losses from this disease are comparatively small, yet on the whole, the disease cannot but be regarded as a threatening menace to wheat culture, especially winter wheat culture in the United States, and hence should merit all possible precautionary and control measures. It is not yet known how the disease will behave in the spring wheat area.

In connection with investigations carried on by the Office of Cereal Investigations, certain wheat varieties are showing promising indications of resistance to the disease. Experience is showing that the disease is not difficult to control. Clean seed sown on uninfested fields, even in infested localities has been shown to produce a perfectly clean crop, this even when close to infested fields. It is not yet known how long the parasite is able to remain viable in infested soils in the central and eastern states.

Black chaff caused by Bacterium translucens var. undulosum S. J. & R.

Black chaff of wheat was reported from a somewhat wider area in 1919 than in the preceding year. In 1919 it was reported from the following states: California, Idaho, Colorado, North and South Dakota, Minnesota, Wisconsin, Nebraska, Iowa, Illinois, Indiana, Kansas, Missouri, Texas, Oklahoma, Arkansas, and Virginia. Negative reports were received from Washington, Oregon, Montana, New Mexico, Georgia, Kentucky, and Michigan.

As to general prevalence and severity the following reports have been received:

Arkansas: "Present in most fields. No evidence of injury." Elliott.

California: Found in one field.

Colorado: "Several isolated cases reported during June - mostly from irrigated sections of south central part of state. Not very severe in any case." Leach.

Idaho: "Only one authentic collection." Hungerford.

Indiana: "Not prevalent." Gardner.

Iowa: "Most severe on winter varieties." Melhus.

Kansas: "This disease was reported from practically all sections of the state in greater or less quantities. It is very difficult to estimate, or even approximate the amount of injury this disease might have caused." Melchers.

"Common in most fields. Present in only traces in many fields. Low spots had often times quite serious infection. Not as common or serious as in 1915." Melchers.

Missouri: One field in Scott County was reported as showing 100% infection. Injury not noted.

Montana: "In no instances have typical cases of this disease been found even in districts where the disease caused from 50-90% reduction in yield last year. Occasional leaf lesions seen which might have been caused by the black chaff organism." Jennison.

North Dakota: "This disease not present in destructive form: only traces apparent in fields examined by me." Bolley.

Oklahoma: "I collected this disease for the first time in 1917 in Payne County, just a short distance from the College, and this summer the same field was badly infected again. It is very common in this county, and in the early season it caused a great deal of injury. During the summer, in going over the state, I found it in many fields where the county agent did not know what it was, and had noticed it in the early season, probably quite common. In one instance we went to one of the stacks and I pulled out a handful of plants consisting of 47, and 40 of them showed the disease. This county (Payne) was very low in yield, and they put it all to the wet weather, but I believe this disease had its part in the decrease." Learn.

South Dakota: "Two to five per cent in some fields; as a rule, less than 1%." Champlin.

On the whole, it is evident that the disease was most general and most severe in Iowa, Missouri, Kansas, and Oklahoma.
No cases of varietal resistance, nor control measures were reported.

Anthracnose caused by Colletotrichum cereale Manns.

Anthracnose of wheat was reported from practically all of the wheat growing sections east of the 100th meridian. It was also reported from Montana. In most states it was rather general, but for the most part, the losses were slight. However, in New Jersey, Virginia, Ohio, and Iowa, it is reported more severe, as follows:

New Jersey: "Very common and apparently destructive." M. T. Cook.

Virginia: "Very destructive locally, especially in south central part. I believe it is a disease of considerable importance for the state as a whole." Fromme.

Ohio: "Very abundant in vicinity of Wooster, Wayne County." Selby. "Experiment Station plots, continuous wheat culture, from 13 to 91% plants infected, infection moderate in severity." Freda Detmers.

Iowa: "Very common; favored by abundant moisture early in spring." I. E. Melhus.

On the whole it is evident that the disease was rather severe locally and that the total losses caused by it no doubt aggregated considerable, even though the average losses for the various states are comparatively low.

Selby reported that the wet formaldehyde seed treatment, (1 pint to 40 gallons) kills spores adhering to surface of grain.

Glume blotch and leaf spot caused by Septoria spp.

Both the Septoria glume blotch and Septoria leaf spot of wheat occurred widely in 1919. The glume blotch occurred most commonly from Indiana eastward and southward; also to some extent in Illinois, Iowa, Missouri, and Kansas. The leaf spot occurred throughout this area also, as well as farther west, throughout the Mississippi and Missouri Valleys, and particularly on the Pacific Coast, being definitely reported there from Washington, Oregon, Idaho, and California. Hungerford also reported, "Some damage to seedlings" in Idaho.

The following reports from the central and eastern states are of interest:

Alabama: "General throughout state. Ranging in severity from very slight to bad." G. L. Peltier.

Indiana: Glume blotch - "Very prevalent, associated with the leaf spot." Gardner.

Leaf spot - "Widely distributed throughout state, almost no fields being free from it. In few cases, however, did it seriously reduce the yield." Gardner.

Iowa: "Found to a high percentage on winter wheat at Agronomy farm at Ames. Very common early in the spring. By this time (June 10) it has worked up the stems to the upper leaves. Trace on glumes." A. L. Bakke.

"Very common; causing seedling blight." I. E. Melhus.

Kansas: Glume blotch - "Caused injury in some fields. Low spots and lodged wheat had worst infection. Although not as widely spread as black chaff, the injury was just as severe in many fields." L. E. Melchers.

Leaf spot - "This disease became conspicuous in some fields in the fall of 1918 and was very prevalent in the spring of 1919, when many of the fields began to turn yellow. It is stated that some fields were plowed up on account of this trouble in southeastern Kansas. For the most part, fields showing infection outgrew the trouble. It appeared again when the plants began to head. This disease has been quite frequently confused with the black chaff disease." L. E. Melchers.

Ohio: Glume blotch - "Rather prevalent at Station (Wooster); no damage. Appears to be quite general over state." A. D. Selby.
Leaf spot - "General and moderately severe during late spring over southwestern and central Ohio. Also marked occurrence at Experiment Station, Wooster." A. D. Selby.

Virginia: Glume blotch - "Septoria on wheat heads unusually prevalent. Incessant rainfall at heading evidently farored development. Reported from many places where farmers had never noticed it before." Fromme.

West Virginia: "Quite a little Septoria infection has been observed in many fields." N. J. Giddings.

The glume blotch was reported also on spelt from Minnesota.

Powdery mildew caused by Erysiphe graminis De C.

Powdery mildew on wheat was more severe in 1919 than usual, especially early in the season in certain of the Atlantic Coast states. This was no doubt chargeable to the unusually mild winter. It was definitely reported from the following states: Washington, Idaho, California, Montana, Kansas, Minnesota, Iowa, Illinois, Indiana, Ohio, Kentucky, Tennessee, West Virginia, Pennsylvania, New York, and Connecticut.

The following reports from Iowa, Kansas, and West Virginia are of interest:

Iowa: "Found where wheat is lodged and where stand is heavy." Bakke.

Kansas: "This was very common in May and June in the wheat crop over the state. It did no damage and ceased spreading after the rainy season passed." Melchers.

West Virginia: "Wheat mildew has been unusually prevalent and has caused some little injury in many wheat fields this year." N. J. Giddings.

Ergot caused by Claviceps purpurea (Fr.) Tul.

Ergot on wheat in 1919 was reported from Illinois (one field, slight infection), Indiana (rare), Minnesota, North Dakota, and Wisconsin. In Minnesota it was reported from Olmstead, Goodhue, Dakota, Hennepin, and Ramsey Counties. In Ramsey County it was reported as having occurred on a number of varieties. In North Dakota the disease was reported from the eastern half of the state, but as most common in the southeastern portion. In Wisconsin ergot on wheat occurred in Rock, Dane, Columbia, La Crosse, St. Croix, and Burnett Counties. In Rock County one field was noted by J. G. Dickson where about 2% of the heads were infected. It is suggested by R. E. Vaughan that possibly ergot may be increasing on wheat in Wisconsin.

Helminthosporium blight caused by one or more species of Helminthosporium.

In Minnesota a seedling blight on both Marquis and durum wheat caused by Helminthosporium sp., was reported as destructive late in May in the Red River Valley and more or less elsewhere in that state. The following note by the Section of Plant Pathology, Minnesota Agricultural Experiment Station, is of especial interest: "Many fields were complete failures at seedling stage and the ground was plowed and planted to flax. Those plants which survived became normal and the fields probably produced a fair crop."

In North Dakota these wheat troubles were reported especially from the eastern half of the state. Bolley reported as follows:

> "This root and seedling trouble has been very destructive throughout the year and generally throughout the state in fields and regions of rather constant cropping, and destructiveness in many cases depends largely on the condition of the seed sown. It is perhaps the most destructive, excepting scab in scab epidemic invasions. The species of Helminthosporium constitute perhaps the most destructive wheat disease in this state this year." (July 15.)
>
> "Very abundant and destructive. Particularly destructive in destroying stools and in the production of black points on the grain, injuring the grain throughout the state, particularly in connection with rather constant (wheat) cropping." (August 1.)

The following additional summary for North Dakota by Professor Bolley is also of importance as bearing on the situation:

> Wheat has suffered severely in this state from the beginning from root and seedling disease because of peculiar soil and atmosphere conditions. In the spring heavy rains, particularly in the valley (Red River) at seeding time, resulted in wet, badly baked land and in poor condition for the growth of the young plants. This was followed by intense drought resulting in stunting and blighting by hot winds followed again by heavy rains in certain regions. In other words, irregular growth conditions have emphasized the destructiveness of the soil and seed borne imperfect fungi, Fusarium, Helminthosporium, etc."
>
> "In durum wheats the parasite known as Helminthosporium has caused extremely large destruction in certain portions of the state this year in the way of destroying the grade of the durum wheat, particularly the varieties of red durum. This organism brings about an excess production of black point which tends to cause great injury to the quality of flour from the standpoint of color and texture."

In South Dakota Manley Champlin reported "Considerable evidence of infection by Helminthosporium on the glumes, especially of durum varieties; grains also affected."

It is conservatively estimated that these troubles caused a loss in North Dakota of about 2% and in Minnesota of about 1%.

Other diseases.

Basal glume rot of wheat caused by Bacterium atrofaciens McCulloch, recently described by Lucia McCulloch (Jour. Agr. Res. Vol. 18, No. 10, 543-551, 1920) is of especial interest. While no data are reported as to the occurrence of this malady in 1919, Miss McCulloch reports that the dis-

ease was found on specimens collected in 1917 and 1918 in the following states: Kansas, Michigan, Minnesota, Missouri, New York, North Dakota, Oklahoma, and South Dakota, and in Alberta, Canada.

Stripe (causes not determined). The so-called stripe of wheat was reported from Missouri, Illinois, Indiana, and New York.

A Rhizoctonia root rot of wheat was reported by E. A. Bessey from Michigan. It was said to occur especially in heavy soils.

Rhynchosporium graminicola was reported by Heald and Dana as attacking wheat in western Washington.

Alternaria sp. was reported on wheat from Howard county, Missouri and from Wayne County, Ohio.

Cladosporium sp. on wheat was reported by M. T. Cook as "Very abundant and apparently destructive" in New Jersey. It was also reported from Minnesota, Missouri, Ohio, and Washington. It may not be improbable that this Cladosporium is a saprophytic development following some more fundamental trouble.

"White spot", a wheat seedling disease of uncertain cause, was reported from the northwestern part of Minnesota. It is briefly described as follows by the Division of Plant Pathology of the Experiment Station: "An interesting disease, was very prevalent in the Red River Valley this spring. No insect nor fungus was found associated. A white band about 2 to 3 mm. wide appeared on the young leaves. The leaves would twist and curl at this point, eventually shrivel, and break off. This often so completely defoliated the plants that they died. Some fields were completely destroyed. Plants which survived the seedling stage grew normally. In some cases fields which looked very sick completely recovered after a rain."

Frost injury to wheat was reported as having caused about 1% loss in Idaho and 5 - 7% loss in Washington. These frost injuries took place after wheat was in head. Heald notes as follows from Washington: "Some fields complete loss, in others scattered, unfilled heads resulted, or blighted tips."

From Indiana, Gardner notes that "Freezing did a great deal of damage to Indiana wheat early in the spring. Much of this wheat did not recover and there is quite a reduction in yield." (July 15).

Injuries from spring freezes were also reported from Illinois, Michigan, and Missouri.

RYE

Stem rust caused by Puccinia graminis Pers.

Stem rust of rye was reported as occurring in slight amounts from Colorado to New York, and from north to south in practically all of the intervening states where rye is grown. It was reported as causing distinct losses only in Minnesota, Wisconsin, Delaware, South Carolina and Georgia. In these states the percentages of loss were estimated at 2, 1, 10, 1 and 2% respectively. In the other states the losses were estimated as so slight as to be difficult to estimate with any degree of accuracy or entirely negligible. On the accompanying map are indicated the occurrence and the estimated percentages of reduction in yield in the states from which reports have been received. The estimated losses are summarized in bushels in Plant Disease Bulletin, Supplement 12, 1920.

In Wisconsin, consistently for a number of years, early and severe stem rust infections on rye have been noted as being distinctly associated with aecial infections on the common barberry, either directly, or through quack grass. In 1911 a striking case was observed where a field of otherwise fine rye was practically totally destroyed by stem rust. Two clumps of heavily infected barberries were at the roadside at the edge of the field. Another field of rye about ten miles distant, under similar growing conditions and no barberries anywhere near, had but very little stem rust in it, and the rust developed so late that a splendid crop of excellent quality was obtained. Since then numerous cases have been followed carefully from early spring on, and stem rust infections traced directly to infected barberries. Evidence seems to indicate, at least in Wisconsin, that when the common barberry is completely eradicated the development of stem rust on this crop coming from other sources will be so greatly delayed as to be of negligible importance.

No rust resistant varieties of rye were reported.

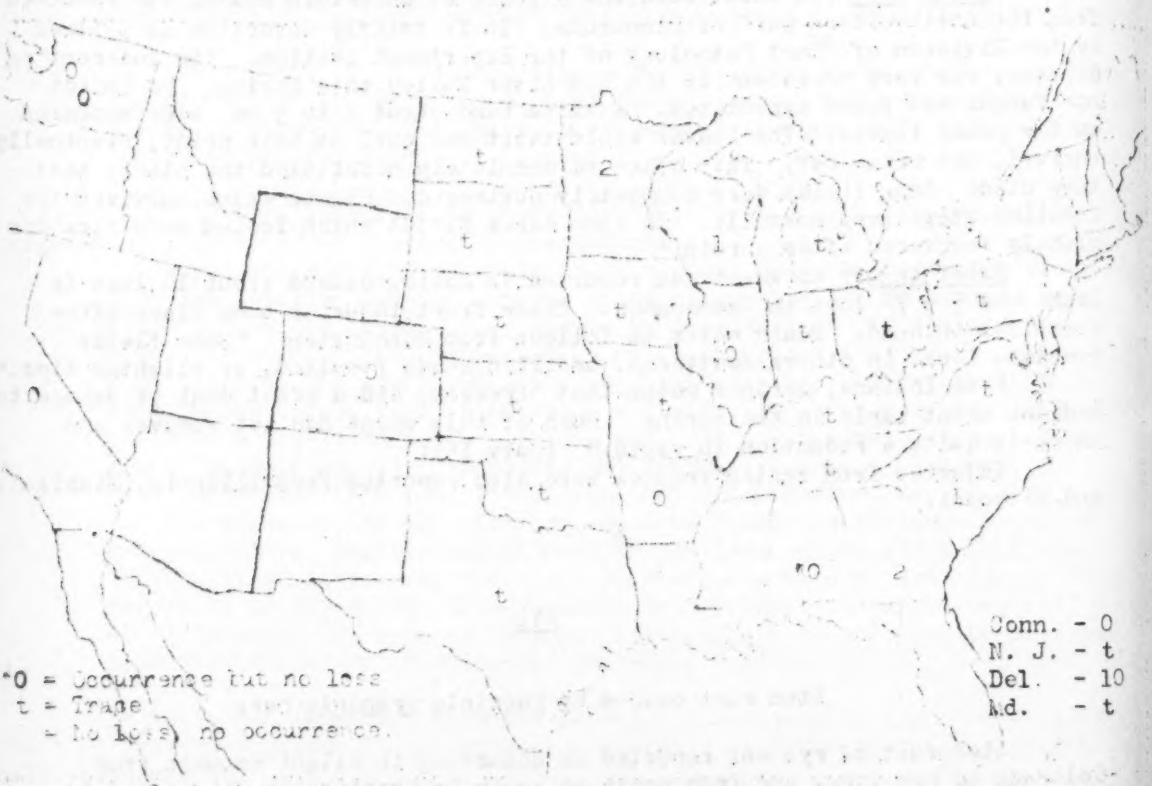


Fig. 8. Estimated percentage reduction in yield from stem rust of rye, 1919.

Leaf rust caused by Puccinia dispersa Erik.

Leaf rust of rye occurred widely distributed in 1919 as usual, and caused marked losses, especially in certain southeastern and eastern states, as is shown on the accompanying map. The severity of the attacks by this disease seems to have been accentuated, as in the case of the leaf rust of wheat, by

the unusually open preceding winter. The estimated losses are summarized in bushels in Plant Disease Bulletin, Supplement 12, 1920.

On winter rye the rust was first noted May 30 in Minnesota and June 1 in Wisconsin. The only early report on spring rye was June 17, in Minnesota.

No outstanding cases of varietal resistance to the disease were reported.

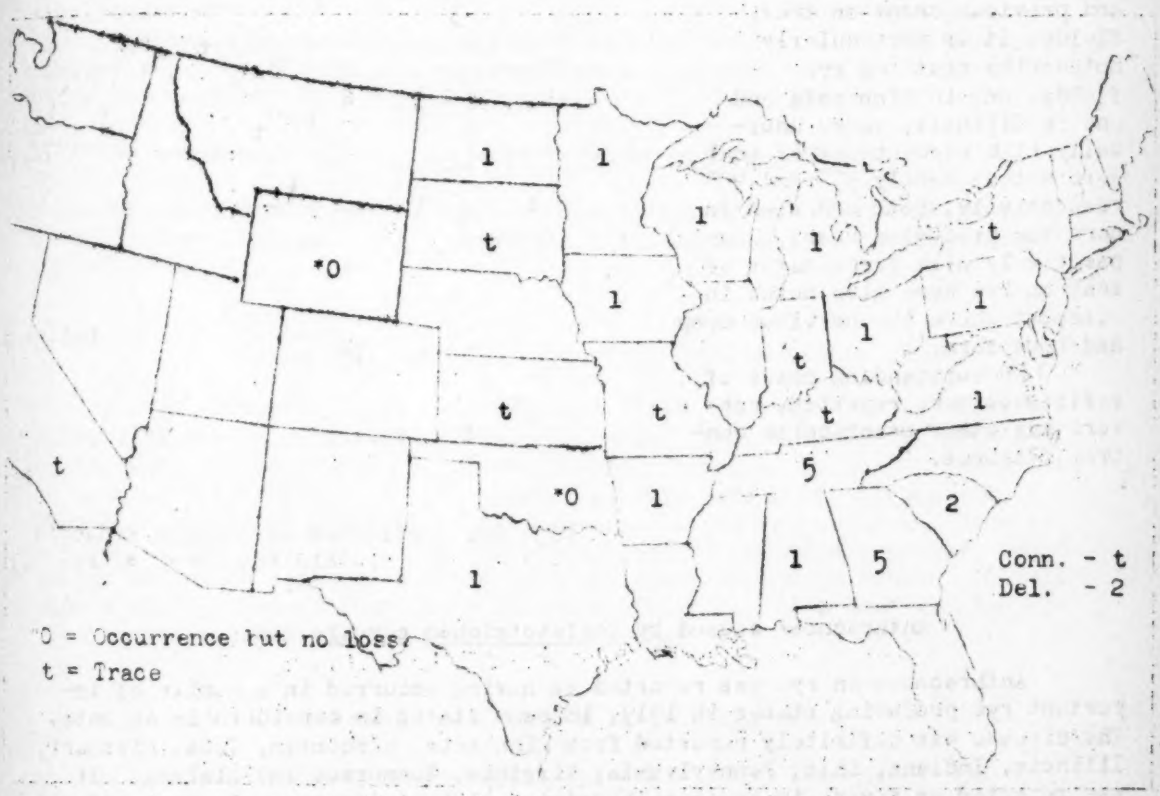


Fig. 9. Estimated percentage reduction in yield from leaf rust of rye, 1919.

Scab (blight) caused by Gibberella saubinettii (Mont.) Sacc.

Scab (blight) of rye was considerably more common and more destructive in 1919 than in preceding years. This disease was reported as causing marked losses in South Dakota, Minnesota, Wisconsin, Iowa, Missouri, Illinois, Indiana, and Virginia. Very slight losses were reported from Delaware, Kentucky, Tennessee, Arkansas, and Oklahoma. A number of unusually severe infections were reported. One field in Minnesota had 97% scab, one field in Illinois showed 90%, and one field in Missouri contained 65% scab. The disease was not reported from the western states. The distribution and estimated percentages of loss are indicated on the accompanying map. The estimated losses in bushels are summarized in Plant Disease Bulletin, Supplement 12, 1920.

It is to be noted that the area of greatest losses coincides very closely with the corresponding area for wheat scab. This might be expected, since rye is known to be susceptible to the attacks of the same parasite which is

the main offender in the case of wheat scab. Hence the same factors were operative on rye as on wheat, as previously presented.

As to the relation of severe cases of scab on rye and previous crops on these fields, it is particularly noteworthy that two rye fields, one in Minnesota and one in Illinois, where unusually high percentages of scab were noted; namely 97% and 90% respectively, both had been in corn the preceding year. Comparatively high percentages of scab on rye were also noted in Missouri where the previous crop had been corn.

No outstanding cases of resistance were reported, nor were any other practicable control measures.

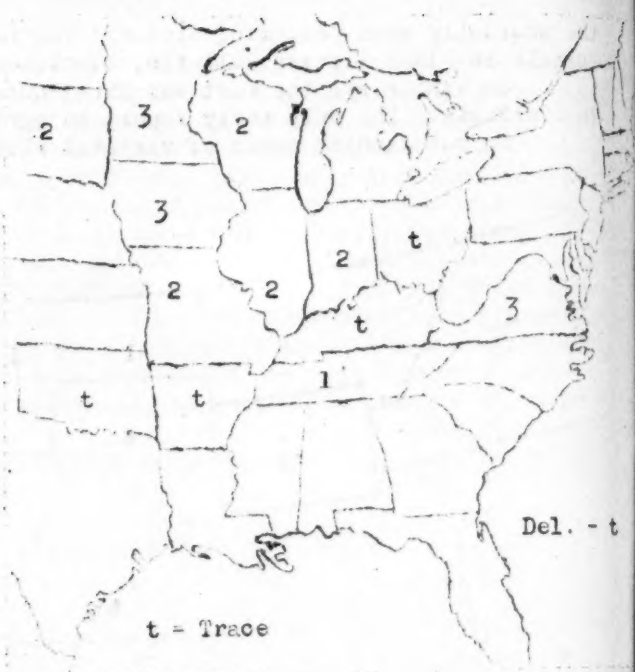


Fig. 10. Estimated percentage reduction in yield from scab of rye 1919.

Anthracnose caused by Colletotrichum cereale Manns.

Anthracnose on rye was reported as having occurred in a number of important rye producing states in 1919, in some states in considerable amounts. The disease was definitely reported from Minnesota, Wisconsin, Iowa, Missouri, Illinois, Indiana, Ohio, Pennsylvania, Virginia, Tennessee and Alabama. It was reported as severe in southern Virginia, Alabama, southern Indiana and different parts of Iowa and Ohio.

In Alabama it was said to be the "worst disease of rye in the state" by E. F. Hopkins. In the Experiment Station plots at Auburn the disease was reported as unusually severe by G. L. Peltier. He has kindly furnished the following data.

Table 11. Relative amounts of anthracnose in certain varieties of rye, Auburn, Alabama, May 20, 1919.

Plot No.	Varieties	Percentage anthracnose	Plot No.	Varieties	Percentage anthracnose
1	Florida	25 - 40	5	Georgia	25
2	Rosen	59	6	Piedmont	50
3	Abruzzi	25	7	Florida	25
4	Ordinary	50	8	Tuscaloosa	25

NOTE. "Of all the rye varieties, Abruzzi, Florida and Tuscaloosa are the most promising under Alabama conditions as far as anthracnose is concerned. The Tuscaloosa rye is apparently the best."

In Iowa it was reported as very common and as having caused 5% reduction in yield.

Fortunately the disease seems to be less severe in the northern states where rye production is more important than southward.

Powdery mildew caused by Erysiphe graminis De C.

Powdery mildew on rye was reported in 1919 from Georgia (Washington County), Iowa (Benton County, common in the bottom lands), and Minnesota (Ramsey County).

Stem smut caused by Urocystis occulta (Wallr.) Rab.

Stem smut of rye was reported from North and South Dakota, Nebraska, Kansas, Minnesota, Wisconsin, Iowa, Missouri, Illinois, Indiana, Michigan, Ohio, Pennsylvania, Virginia, South Carolina, Georgia, Texas, and Arkansas. In each of these states it was reported as very slight or a trace. In Minnesota, where it seems to be most general, it was reported as "General but very light this year." At Manhattan, Kansas, Melchers reported, "Only slight amount on Agronomy nursery in grain from shipped in seed." Champlin made a similar report from South Dakota as follows: "A trace in Rosen rye from Michigan. None in native rye."

Head smut caused by Ustilago sp.

Head smut of rye, previously noted in Indiana, Tennessee, and Virginia, was reported by C. T. Gregory as having occurred in two fields in St. Joseph County, Indiana, June 4, 1919. He reported it as very rare.

Ergot caused by Claviceps purpurea (Fr.) Tul.

Ergot on rye was reported in 1919 from all of the Upper Mississippi Valley states and west to North and South Dakota, Nebraska, and Kansas, and east to, and including, West Virginia and Pennsylvania. In a number of states it was reported as slightly less than the preceding year. The following reports are of especial interest:

Illinois: "Ergot does not seem to be as abundant as last year, but I have observed 60% infection in fields where volunteer rye has appeared in clover and wheat." H. W. Anderson.

Iowa: "Common. Ergot also very common on wild grasses." I. E. Melhus.

Kansas: "It is interesting to call attention to the fact that ergot of rye occurs very rarely in this state, although a very small acreage

of rye is planted, still the amount of ergot that is found is very small in proportion to the acreage." L. E. Melchers.

Michigan: "Common, but not doing very much damage. Brine treatment coming into use." L. A. Bersey.

North Dakota: "Ergot is reported from many parts of the state and it has been observed in numerous fields, but not quite as pronounced this year in this region as in previous years. However, it is sufficiently abundant to indicate, as in previous years, that this disease is to become one of the most destructive and difficult to handle of the rye troubles in this state." H. L. Folley.

West Virginia: "Specimens collected in Monongalia County and about 5% of heads infected in the field examined." N. J. Giddings.

Wisconsin: "More ergot than for several years. One field in Outagamie County showed 95% of plants having one or several sclerotia to the head." R. E. Vaughan.

Other Diseases

A bacterial disease on rye was reported from Idaho by Hungerford.

Septoria was reported on rye from Texas, Minnesota (leaves and nodes), Wisconsin (leaves), Ohio (leaves), and Indiana (heads).

Rhynchosporium blight caused by Rhynchosporium secalis (Heins.) Davis was reported by Heald and Dana from western Washington. It also occurred in Wisconsin.

Helminthosporium sp. was reported as attacking rye stems in Oklahoma and Minnesota.

Epicoccum sphaerosporium was reported on rye from Minnesota.

"Broken stem" disease of rye presumably caused by an associated species of Mycosphaerella was reported from Sandusky County, Ohio by Freda Detmers.

Sterility in rye, cause not determined, was reported by J. L. Seal as causing marked losses (as high as 50%) in certain fields in South Carolina.

BARLEY

Covered smut caused by Ustilago hordei (Pers.) K. & S.

Covered smut of barley was reported as having occurred very generally throughout barley growing sections as in previous years. From a few states the losses from this disease were reported as a little less than the preceding year. On the whole, however, they are comparatively low except in a few states.

In a number of individual fields in different states rather high percentages of covered smut of barley were noted in the course of the cereal disease survey as follows:

Table 12. Highest percentages of covered smut of barley in individual fields as noted in the cereal disease survey in 1919.

States	Highest %	States	Highest %
New York	2	Minnesota	20
Pennsylvania	4	Iowa	4
Virginia	3	Missouri	3
Kentucky	15	North Dakota	t
Tennessee	10	Nebraska	3
Alabama	2	Kansas	2
Texas	60	Montana	8
Oklahoma	20	Colorado	5
Ohio	15	Idaho	25
Indiana	8	Washington	12
Wisconsin	3	California	32

On the accompanying map are indicated the estimated percentages of reduction in yield where the disease was reported. These losses summarized in bushels are given in Plant Disease Bulletin, Supplement 12, 1920.

Fig. 11. Estimated percentage reduction in yield from covered smut of barley 1919.

In some states the losses from this disease exceed those from the loose smut of barley and in others the reverse seems to be true. In a number of states the losses from these two smuts are about equal.

From Montana, H. M. Jennison reported that this disease was less in 1919 than usual, "partly, it would appear, on account of the extreme dryness throughout the season and partly on account of more general and successful control treatments."

No outstanding cases of varietal resistance were reported. However, from Minnesota it is reported by the Section of Plant Pathology of the College and Experiment Station that Manchuria barley was found more heavily smutted than Six Row barley (Manchuria av. 1.4%; Six Row av. .7%).

As for control measures the formaldehyde wet method was the most common seed treatment except in California where the copper sulphate method also was used extensively. The formaldehyde dry method was reported effective from Kansas and Washington as follows:

Kansas: "The dry formaldehyde method will control the covered smut of barley and seems quite advisable for use in controlling this disease." L. E. Melchers.

Washington: In comparing effectiveness of the wet and dry methods of formaldehyde seed treatment for barley Heald reported: "Best results with dry method experiment of 1919."

Loose smut caused by *Ustilago nuda* (Jens.) K. & S.

Loose smut of barley, although generally present, was reported from a number of states to have been somewhat less destructive in 1919 than usual. While the percentages of loose smut found in the course of the cereal disease survey were commonly low, a number of rather unusually high percentages were noted. These being of especial interest are given by states in the following table:

Table 13. Highest percentages of loose smut of barley in individual fields as noted in the cereal disease survey in 1919.

States	Highest %	States	Highest %
New York	5	Iowa	30
Pennsylvania	2	Missouri	4
Kentucky	2	Nebraska	3
Tennessee	4	Kansas	.3
Texas	65	Montana	3
Oklahoma	4	Colorado	1.3
Ohio	25	Idaho	1
Indiana	25	Washington	1
Wisconsin	8	California	50
Minnesota	20		

On the whole, loose smut of barley was more severe than covered smut particularly in Indiana, Ohio, and Kentucky. In certain other states it was less severe and in still others about the same.

On the accompanying map are indicated the estimated percentages of reduction in yield where the disease was reported.

No differences of varietal susceptibility were reported. Control measures such as the modified hot water method of seed treatment are apparently but little used.

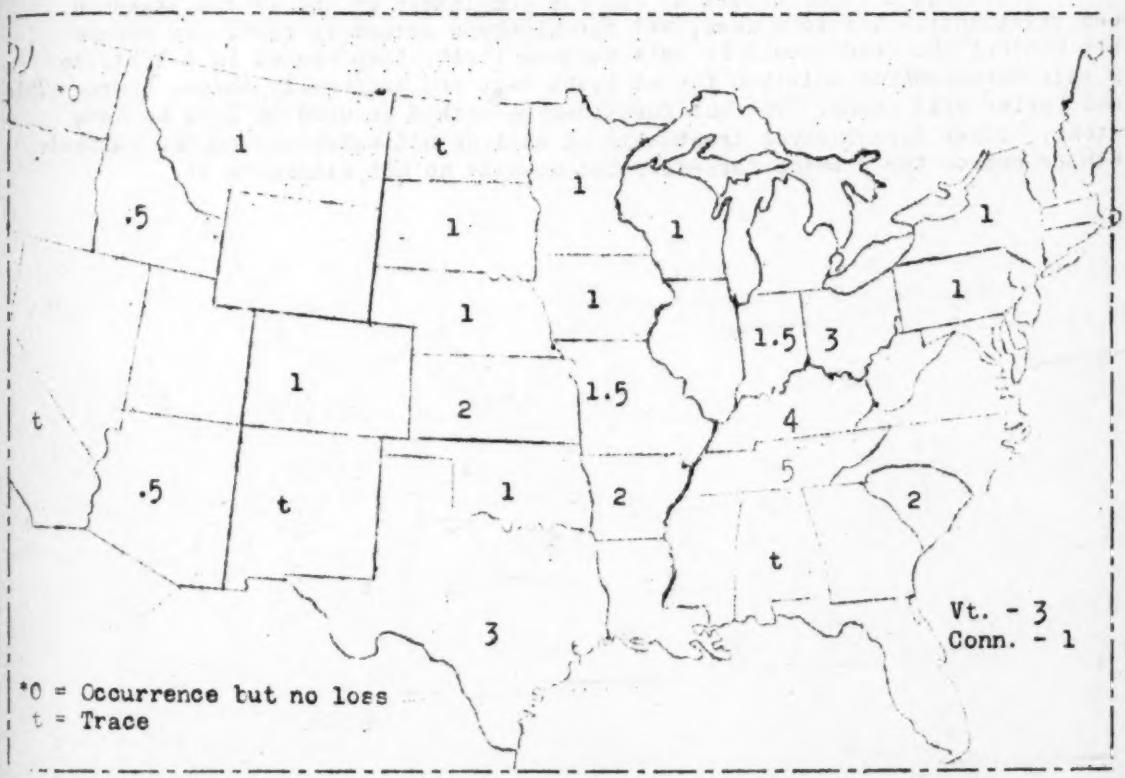


Fig. 12. Estimated percentage reduction in yield from loose smut of barley, 1919.

Stripe caused by Helminthosporium gramineum Rab.

Stripe of barley was reported from a number of states in 1919. In some states, particularly Iowa and Colorado, it was reported as severe. In Wisconsin the disease was much less severe than for a number of years. From Iowa, R. O. Cromwell reported finding fields with as high as 35% of plants destroyed by stripe. In Colorado, Leach reported that in "a few fields as high as 25% of plants were completely killed". From Michigan, G. H. Coons reported, "Barley stripe common; early attack exceptionally severe".

On the accompanying map are indicated the estimated percentages of reduction in yield in states from which reports were received. It is of especial importance to note that this disease is occurring not only in the North on spring barley, but also in the South on winter barley.

While it is well known that this disease is seed borne, it is of especial interest when data is secured on its introduction into new sections. Two such bits of data were received in 1919. L. E. Melchers reported from Kansas that "The stripe disease of barley was found in some parts in the college nursery, seed having been sent in from some other state. None of the barley Helminthosporium diseases have ever been found occurring in any of the commercial fields." L. H. Leonian reported from New Mexico that the disease was particularly severe in Dona Ana County, in the southern part of the state, and that it had been traced to infected seed bought from a Colorado seedsman and distributed among farmers of that County.

The disease is difficult to control completely by any of the standard seed treatments. The long soak, wet formaldehyde method is best. To secure best control the seed should be well cleaned first, then soaked in a 1 pt. to 30 gal. formaldehyde solution for at least two, and preferably three, hours. This good barley will stand. The hot formaldehyde method is used in Iowa to some extent. Other formaldehyde treatments as well as hot water and copper sulphate methods reduce the disease markedly, but usually do not eliminate it.

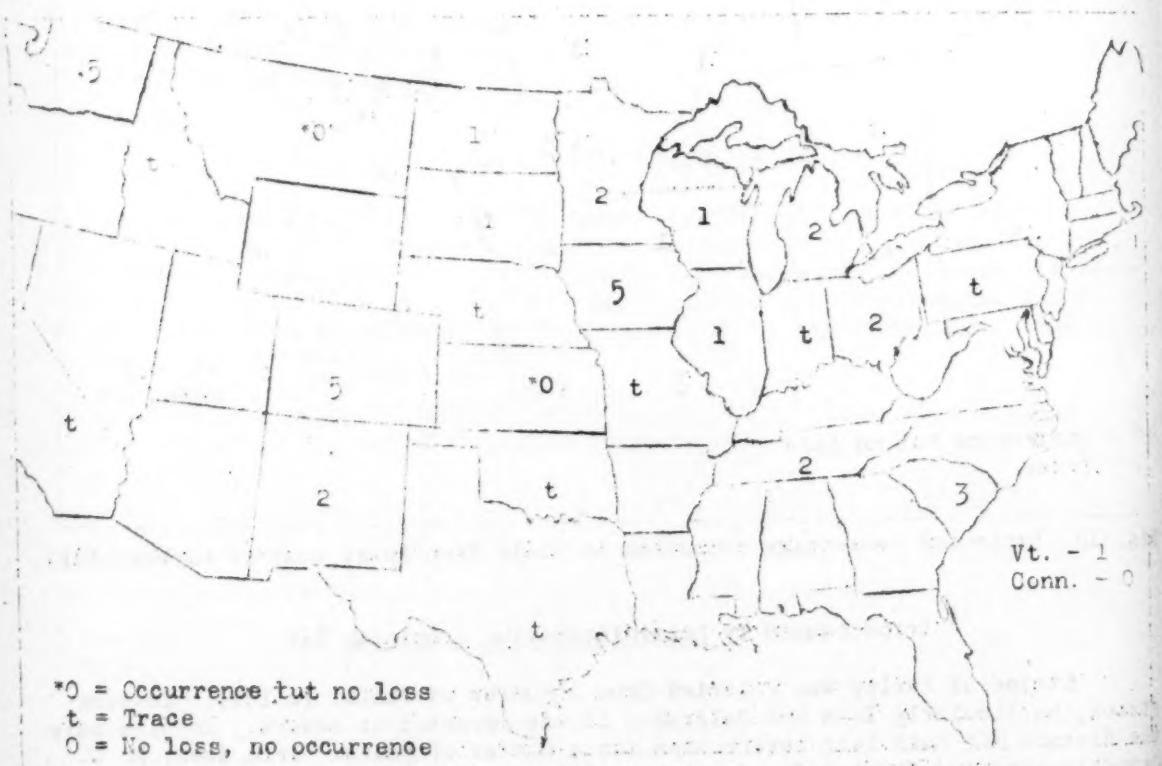


Fig. 13. Estimated percentage reduction in yield from stripe of barley, 1919.

Stem rust caused by Puccinia graminis Pers.

Stem rust of barley caused marked losses in the important barley production area of the Upper Mississippi Valley in 1919. In other sections losses

from this disease were small. On the accompanying map are indicated the range of occurrence and percentages of estimated loss in the various states where losses were reported. The estimated losses are summarized in bushels in Plant Disease Bulletin, Supplement 12, 1920.

In general, the range of the more severe losses coincides rather closely with those caused by the same species of fungus on wheat and rye. This, no doubt, is chargeable to the fact that barley is a common host to the specialized races of this rust on wheat and rye. The losses from attacks of stem rust on barley, while considerable, are not excessive, due in general to the early maturity of the crop.

No outstanding cases of varietal resistance were reported.

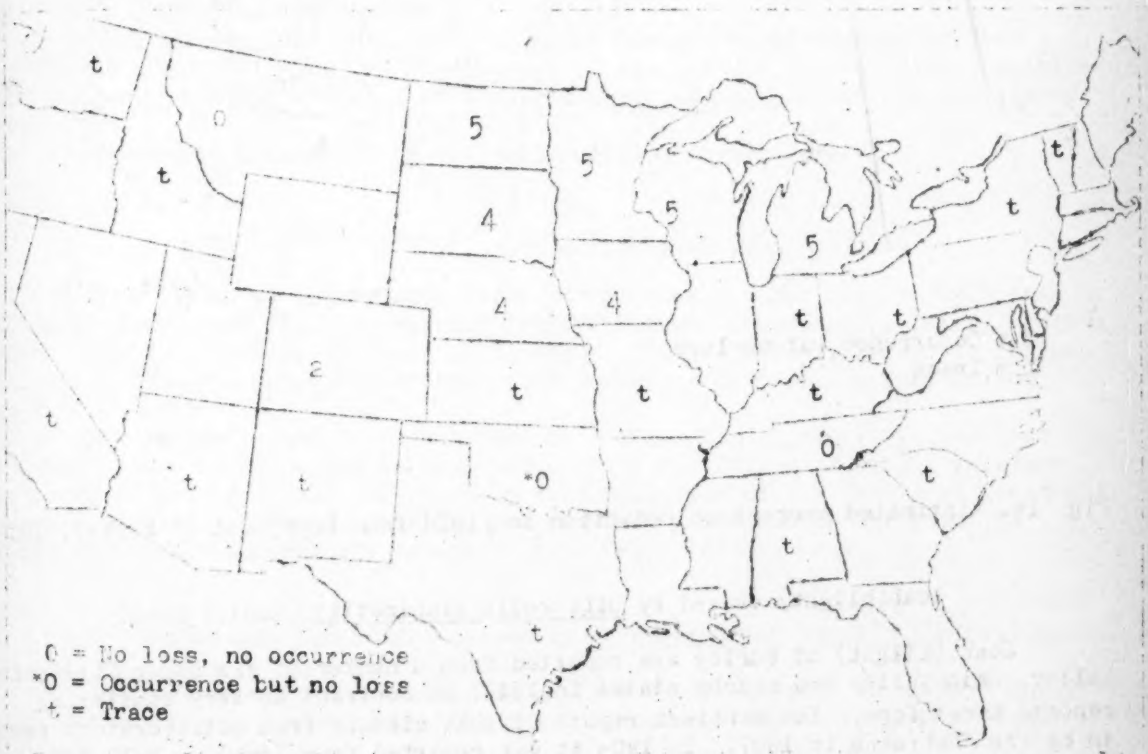


Fig. 14. Estimated percentage reduction in yield from stem rust of barley, 1919.

Leaf rust caused by Puccinia simplex (Koern.) Erik. & Henn.

The leaf rust of barley, while rather widely distributed during 1919, was reported as causing no appreciable losses except in Pennsylvania, Tennessee, and California, as shown on the accompanying map. In the northern Mississippi Valley states this rust is most commonly seen on volunteer barley in the fall. In California, where barley is commonly sown in the fall, it becomes much more abundant in the regular crop. In that state it was reported most abundant in Monterey and Santa Clara Counties.

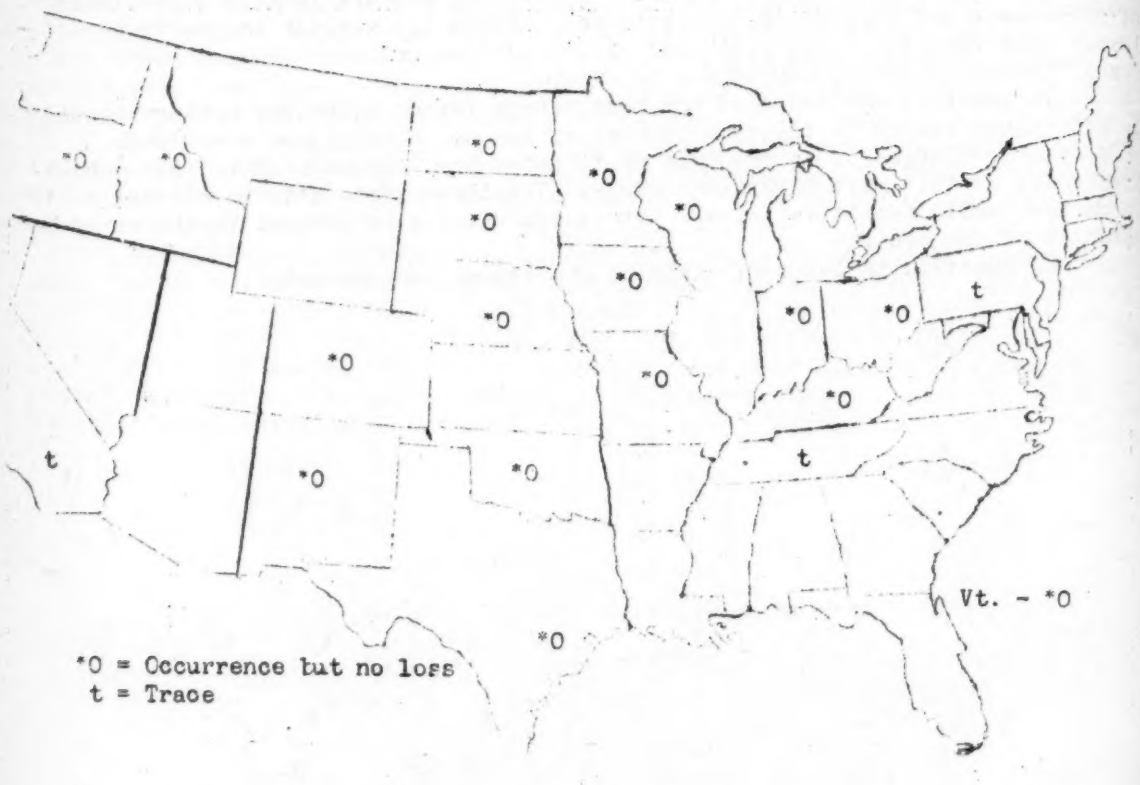


Fig. 15. Estimated percentage reduction in yield from leaf rust of barley, 1919.

Scab(blight) caused by Gibberella saubinettii (Mont.) Sacc.

Scab (blight) of barley was reported from a number of the Upper Mississippi Valley, Ohio Valley and nearby states in 1919, in contrast to very scattering reports heretofore. The earliest report of this disease from collaborators seems to be from Nebraska in 1907. In 1909 it was reported from Iowa; in 1915 from Minnesota; in 1918 from Iowa, Minnesota and Wisconsin; in 1919 from North and South Dakota, Minnesota, Wisconsin, Iowa, Missouri, Illinois, Indiana, Ohio, Pennsylvania, Kentucky and Tennessee. In Iowa and South Dakota the disease was reported as rather severe on barley on the average, and causing an estimated loss of about 3 - 5%. In Missouri, Kentucky and Tennessee losses were appreciable although slight, estimated at 1%. In a number of cases rather high percentages of scabbed barley heads were noted. Individual fields in Kentucky and Tennessee were observed where 50 and 40% of the heads were scabbed, respectively. In Minnesota the highest percentage noted was 30%; in Iowa 20%; in Missouri 10%. On the whole, the general infection area on barley coincides in general with that where the wheat scab epidemic was severe, hence it is not surprising that the disease on barley should have been found to occur more extensively in 1919 than heretofore.

As to relations of these high percentages of scab on barley to previous crops on those fields, it is particularly interesting to note that where these highest percentages of scab in barley occurred in Minnesota, Iowa and Missouri,

the preceding crop, in each case, had been corn. In Tennessee, however, the preceding crop was reported as having been cowpeas.

Net blotch caused by Helminthosporium teres Sacc.

Net blotch of barley was reported in 1919 from a wider area than the preceding year. It was reported from California, Oregon, Idaho, Montana, North and South Dakota, Minnesota, Wisconsin, Iowa, Kansas, Texas, Missouri, Illinois, Indiana, Michigan, Ohio, New York and Vermont. In most cases the attacks were slight. However, in the Upper Mississippi Valley and eastward the disease was rather severe in some cases, especially in Wisconsin and Michigan where the plants were defoliated prematurely.

In Minnesota, Mariout and U. S. Wales barleys were reported by the Section of Plant Pathology of the College of Agriculture and Experiment Station as "the most severely attacked of twenty-one varieties grown on the University Farm".

Known seed treatments do not fully control the disease.

Spot blotch caused by Helminthosporium sativum P.K.&B.

Spot blotch of barley also was reported from a wider area in 1919 than the preceding year. It was reported from California, Washington, Idaho, Montana, North Dakota, Minnesota, Wisconsin, Nebraska, Iowa, Missouri, Texas, Tennessee, Illinois, Indiana, Ohio, Pennsylvania and Vermont. In no cases were losses said to be severe.

The ordinary seed treatments do not control the disease. It has been recently found at Wisconsin in cooperation with the Office of Cereal Investigations, (Jour. Agr. Res. 18:379,1920) that some form of dry heat seed treatment seems promising. However, this has not yet been perfected to the point of being applicable in practice except on very small lots of seed.

Rhynchosporium blight caused by Rhynchosporium secalis (Heins.) Davis.

The Rhynchosporium blight of barley was severe locally in central California, western Oregon, western Washington, and was reported as slight in Idaho, Montana, and Wisconsin.

Promising indications of disease resistance were reported by Johnson and Mackie (Phytopathology 10:54,1920). It was noted that certain selections from two barley varieties, Mariout and Tennessee Winter, showed rather striking evidences of resistance in comparison with a large number of other varieties grown along side in the same series of variety tests. Fortunately both of these barley varieties, Mariout and Tennessee Winter, are adapted agronomically to California conditions.

Anthracnose caused by Colletotrichum cereale Manns.

Anthracnose on barley was reported from but four states in 1919; namely, Minnesota, Tennessee, Texas and Wisconsin.

Ergot caused by Claviceps purpurea (Fr.) Tul.

Ergot on barley was reported in 1919 from North Dakota, Minnesota, Wisconsin, Iowa, Missouri, and Indiana, in all cases as rare or a trace. In Minnesota, in addition to being reported on common barley (Hordeum vulgare) from a number of counties, it was reported on six-row barley (H. hexastichon) from Ramsey County, and on two-row barley (H. distichon) from Ramsey and Stevens Counties.

Other diseases.

Bacterial blight of barley, caused by Bacterium translucens J. J. & R., was reported as having occurred to a limited extent in Idaho, Montana, Minnesota, Wisconsin, Iowa, Arkansas, and Ohio. In Arkansas W. R. Rosen reported the disease severe on barley in seedling stage.

Atanasoff and Johnson reported (Jour. Agr. Res. 18:386, 1920.) that the seed borne infection from this disease could be eliminated by severe dry heat treatment.

Powdery mildew of barley (Erysiphe graminis De C.) was reported as slight from Idaho, Montana, Minnesota, Wisconsin, Indiana, Pennsylvania, and Tennessee and no doubt occurred much more extensively.

Septoria sp. on barley was reported from Idaho, North and South Dakota. No injury reported.

A "foot rot", causal fungus not determined, was reported from western Washington by Heald and Dana.

Stripe rust on barley caused by Puccinia glumarum (Schm.) E. & H. was not reported from any state in 1919.

The so-called false stripe of barley, cause not known, was reported from North Dakota, Wisconsin, and Missouri.

Frost Injury to barley was reported by C. W. Hungerford as common in Idaho in 1919 causing, on the whole, about 5% loss in that state. He states also that, "Heavy frosts when heads were emerging from boot killed part of spiklets in heads."

OATS

Smut caused by Ustilago avenae (Pers.) Jens. and U. levis (K. & S.) Mag.

The smuts of oats were reported from almost every state in the Union. No reports were received from a few states. No doubt these smuts occurred at least to some extent wherever the crop was grown. However, it was reported from a number of states that there was, on the whole, less smut in oats in 1919 than in previous years.

On the accompanying map is indicated the estimated percentages of loss in the various states from which reports were received. The estimated losses summarized in bushels are given in Plant Disease Bulletin, Supplement 12, 1920.

While these state averages are mostly comparatively low in different states, a number of fields with very high percentages of smut were observed during the course of the cereal disease survey. These are given in the following table:

Table 14. Highest percentages of smuts of oats in 1919 as reported by the cereal disease survey.

State	Highest percentage reported		State	Highest percentage reported	
	Covered smut	Loose smut		Covered smut	Loose smut
New York	48.	14.	Nebraska	6.	3.
Pennsylvania	16.	30.	Kansas	20.	20.
Maryland	0.	14.	Kentucky	0.	4.
Virginia	t.	35.	Tennessee	10.	25.
Georgia	2.	12.	Alabama	42.	20.
Ohio	24.	24.	Texas	24.	30.
Indiana	12.	24.	Oklahoma	10.	10.
Illinois	4.	50.	Arkansas	14.	15.
Wisconsin	5.	9.	Montana	40.	3.
Minnesota	30.	5.	Colorado	.7	3.6
Iowa	8.	24.	Idaho	60.	20.
Missouri	20.	26.	Washington	40.	12.
North Dakota	10.	0.	California	100.	C.

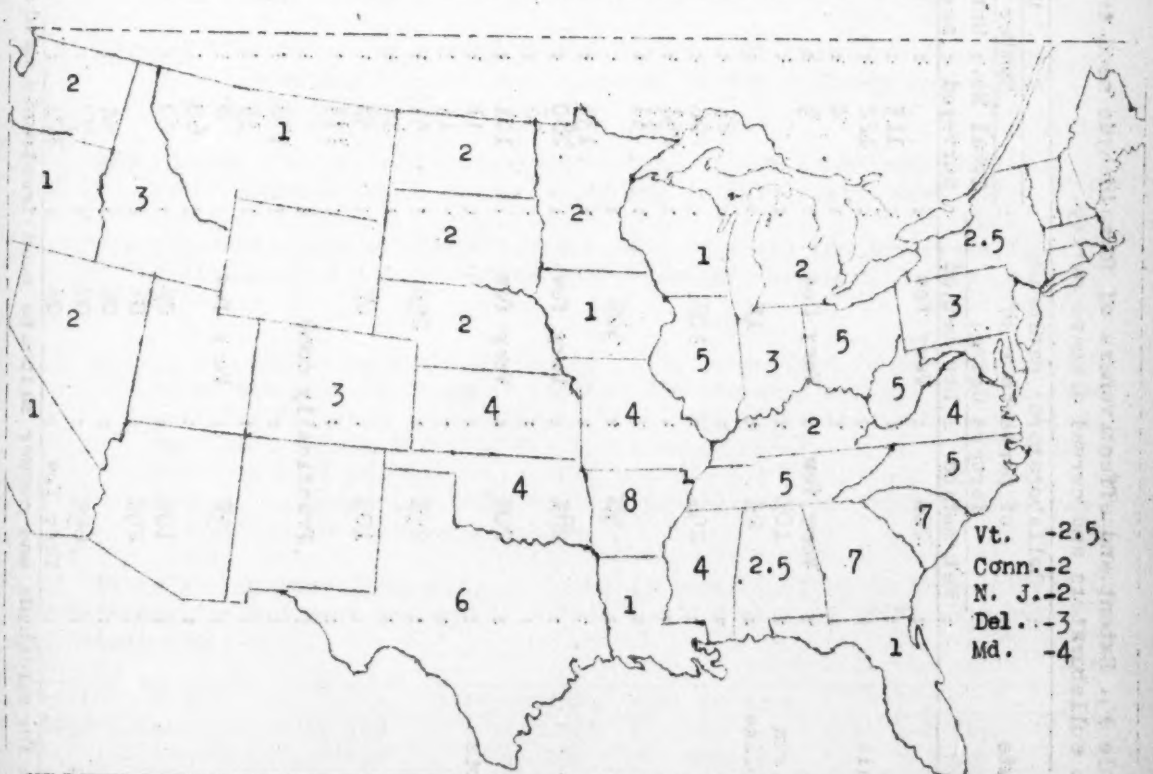


Fig. 16. Estimated percentage reduction in yield from smuts of oats, 1919.

Table 15. Extent and effectiveness of formaldehyde seed treatments for prevention of smuts of oats, according to collaborators and cereal disease survey.

State	Collaborators' estimates of percentage of farmers using:		Data from cereal disease survey				
			Number of fields			Percentage smut	
	Wet method	Dry method	Total No. surveyed	Untreated seed sown	Treated seed sown	Seed not treated	Seed treated
Vermont	20%	Very few					
New York			113	68	45	4.8	.8
Pennsylvania			122	93	29	3.5	.2
Maryland			4	4	0	7.5	0.
Virginia	Very few	Very few	5	5	0	10.8	0.
West Virginia	10%						
South Carolina	2%	1%					
Georgia			23	11	12	7.3	.5
Ohio	25%	10%	26	20	6	9.2	2.
Indiana			254	182	72	5.4	.4
Illinois			31	27	4	5.4	.5
Michigan	5%	50%					
Wisconsin			139	112	27	.9	.5
Minnesota	28%	Very few	280	232	48	3.1	.7
Iowa			78	65	13	.8	.1
Missouri	20%	Very few	101	75	26	6.5	.6
North Dakota			11	8	3	0.	0.
Nebraska			13	7	6	3.8	T.
Kansas	25%	25%	51	32	19	11.6	.9
Kentucky			14	13	1	.5	0.
Tennessee	10%	0%	38	36	2	3.9	T.
Alabama			113	99	14	3.	.4
Louisiana	Practically none						
Texas			176	153	24	7.2	1.7
Oklahoma			33	33	0	6.1	0.
Arkansas	5%	Very few	8	7	1	10.7	1.
Montana			60	47	13	.4	T.
Colorado	10%	0%	20	15	5	.7	.8
Nevada	25%	0%					
Idaho		0%	94	60	34	5.4	1.4
Washington	65%	0%	72	21	*51	5.7	1.2
California	Very few	0%	109	108	1	1.5	0.

* Both formaldehyde and copper sulphate seed treatments used.

No outstanding cases of varietal resistance were reported. Formaldehyde seed treatments were reported very generally effective and fairly commonly practiced in 1919 in certain states, in others less so. Both wet and dry methods were used.

Table 15, which is largely self-explanatory, gives data on extent and effectiveness of seed treatments as applied to oats for prevention of smuts.

As to the relative effectiveness of the dry and wet methods of formaldehyde seed treatment, collaborators were requested to report: "Results with dry formaldehyde (pint to pint) treatment for oats as compared with the ordinary sprinkling, 1-40 (1 pt. to 40 gal.) method."

The following reports were received. Other states either had no data or did not report.

Pennsylvania: "Dry formaldehyde method has largely supplemented the 'wet method' in treatment of oats." C. R. Orton.

Arkansas: "The dry formaldehyde method (1-1) of controlling oat smuts was found to be satisfactory, but not as complete a control as the 1-40 method. A few smutted heads appeared in the dry treated grain." Elliott.

Michigan: "Excellent." Coons.

Missouri: "Dry treatment with formaldehyde for oats is rarely used in this state." Maneval.

Kansas: "The dry formaldehyde treatments for oat smut have given equally satisfactory results when compared to the ordinary sprinkling method." Melchers.

Washington: "Not as satisfactory according to our Experiment Station experiments of 1918; better according to 1919 tests." Heald.

Vermont: "We recommend both, but the county agents and farmers are familiar with the wet method and Vermonters are slow to change." Gilbert.

Idaho: The following was reported by C. W. Hungerford on tests carried on at the Idaho Experiment Station with several methods of seed treatment for oat smut prevention. Three lots of smutted oats were used. The results from three of the treatments, namely; 1 pt. to 40 gal. wet method, 1 pt. to 10 gal. wet method, and 1 pt. to 1 pt. dry method, in comparison with results from untreated controls, are summarized in the following table:

Table 16. Summary of results of tests in Idaho in 1919 on comparative effectiveness for oat smut prevention of wet and dry methods of formaldehyde seed treatment.

Seed lots	Percentage of smut in crop			
	Untreated controls	1-40 wet method	1-10 wet method	1-1 dry method
A	12	0	0	1
B	3	0	0	0
C	2	0	0	0

South Carolina: The following was reported by J. L. Seal on tests carried out by a student under his direction at Clemson College. Two lots of seed were used: A = Red Rust Proof oats, smutted; B = Fulghum oats, trace of smut. Two seed treatments, 1 pt. to 40 gal. wet method and 1 pt. to 1 pt. dry method, were used. The results are summarized in the following table:

Table 17. Summary of results of tests in South Carolina in 1919 on wet and dry methods of formaldehyde seed treatment on oats.

Seed treatments	Germination percentages		Percentages of smut in crop	
	Seed lot A	Seed lot B	Seed lot A	Seed lot B
Controls, untreated	100.0	85.1	6.0	2.8
Formaldehyde, 1 to 1 dry method	71.3	66.3	0.0	0.0
" " " " "	54.0	55.4	0.0	0.0
" " " " "	60.8	56.7	0.4	0.0
Controls, untreated	97.3	82.4	9.2	5.4
Formaldehyde 1 to 40 wet method	66.3	56.7	0.2	0.0
" " " " "	54.0	78.4	0.0	0.0
" " " " "	83.8	79.7	0.0	0.0
Controls, untreated	82.4	93.2	7.6	4.8

Stem rust caused by Puccinia graminis Pers.

Stem rust of oats occurred over a wide range in 1919 as in previous years. In a number of states, notably Minnesota, the Dakotas, and Nebraska, the disease caused considerable losses while in many others the losses from this disease on oats was negligible. On the accompanying map are indicated the occurrence and estimated percentages of reduction in yield in the various states from which reports have been received. The estimated losses are summarized in bushels in Plant Disease Bulletin, Supplement 12, 1920.

While in general the percentages are low, it is well known that stem rust is a limiting factor in the successful culture of oats in southern California. Hence the figures on losses in California greatly underestimate the actual situation, for if the rust attacks were less severe there, or if suitable rust resistant varieties were available for culture, a much greater acreage of oats would undoubtedly be grown in that section.

A few years ago the writer (Johnson) learned of certain rather unusual indirect effects of these severe attacks of stem rust on oats in southern California upon certain phases of agricultural practice there. In inspecting barley for diseases south of San Diego, especially in the vicinity of Chula Vista, it was found that barley was grown there chiefly for hay. Upon inquiry it was learned that other more desirable grains, especially oats were not grown for hay because of the severity of stem rust attacks on those grains, while it was found by experience that barley rusted but very little. The writer's observations as to these points, especially as to oats and barley, tended to

substantiate this. That is, the rather limited amount of volunteer oats found was unusually heavily attacked by stem rust, while barley was rusted comparatively little and only with the barley leaf rust, which did but little damage.

The chain of rather unusual indirect effects referred to above, that this condition had upon certain phases of agricultural practice, may be summed up briefly as follows: In the first place, horses, in general, are preferred to mules for use on the extensive lemon plantations in that section. Further, the common method of producing hay there for farm animals is by growing grains and cutting and curing same just before maturity. Oats thus handled makes good hay and is satisfactory for horses. But, as stated above, the growing of oats for this purpose had to be discontinued because of the unusually severe attacks of stem rust, and barley was substituted.

It was found that the awns on the barley used for hay irritated the mouths of the horses to the extent of making them so sore that the horses did not do well. On the other hand, it was found that mules were not bothered in this way by the barley hay. On account of this general situation the horses formerly owned on the large lemon ranch visited had been disposed of and mules substituted.

The stem rust of oats was reported as serious locally in northeastern Pennsylvania. Here the severe attacks were associated with aecial infections on the common barberry. Local outbreaks were also reported from Vermont Both in North and South Dakota the more severe attacks were in the eastern sections of those states.

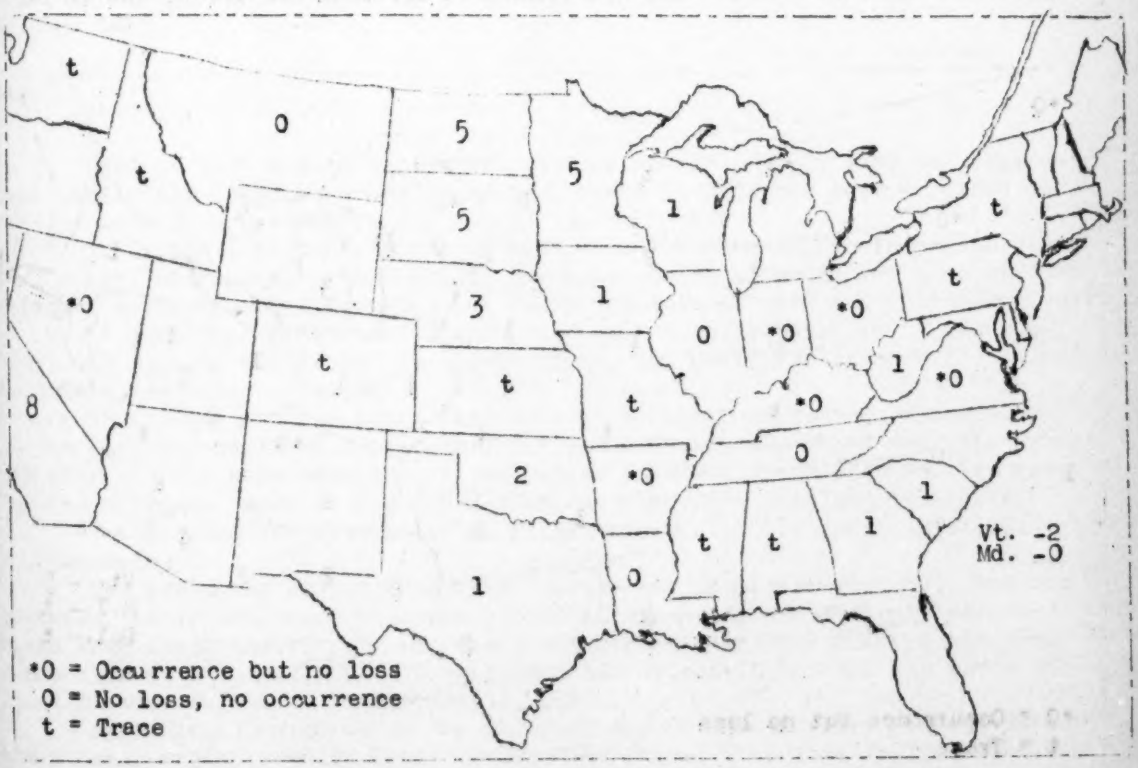


Fig. 17. Estimated percentage reduction in yield from stem rust of oats, 1919.

No outstanding cases of rust resistance were noted, although in Texas it was reported that the varieties Texas Rust Proof and Ferguson were somewhat less rusted than other varieties. Also from Oklahoma Texas Rust Proof was reported as not so badly rusted as other varieties. As with most other grains, it was noted that late varieties of oats tend to rust more heavily than the earlier varieties. It was noted, particularly in South Dakota and Wisconsin, that the variety Sixty Day ripened sufficiently early to escape the severe attacks of the rust. In Minnesota the oats varieties were listed in the following order as to relative susceptibility to rust, the least susceptible first: White Russian, Green Russian, Swedish Select, Silvermine, White. It was noted, however, that the estimated percentages of rust on these varieties were not very widely separated.

Crown rust caused by Puccinia coronata Cda.

Crown rust of oats occurred widely during 1919, as in previous years. On the accompanying map are indicated the observed geographic range and estimated percentages of reduction in yield where losses were reported. The estimated losses are summarized in bushels in Plant Disease Bulletin, Supplement 12, 1920. In general, the highest percentages of loss were relatively the greatest in the southern and southeastern states and in the northern Mississippi Valley. In the former general region winter oats are grown, and in the

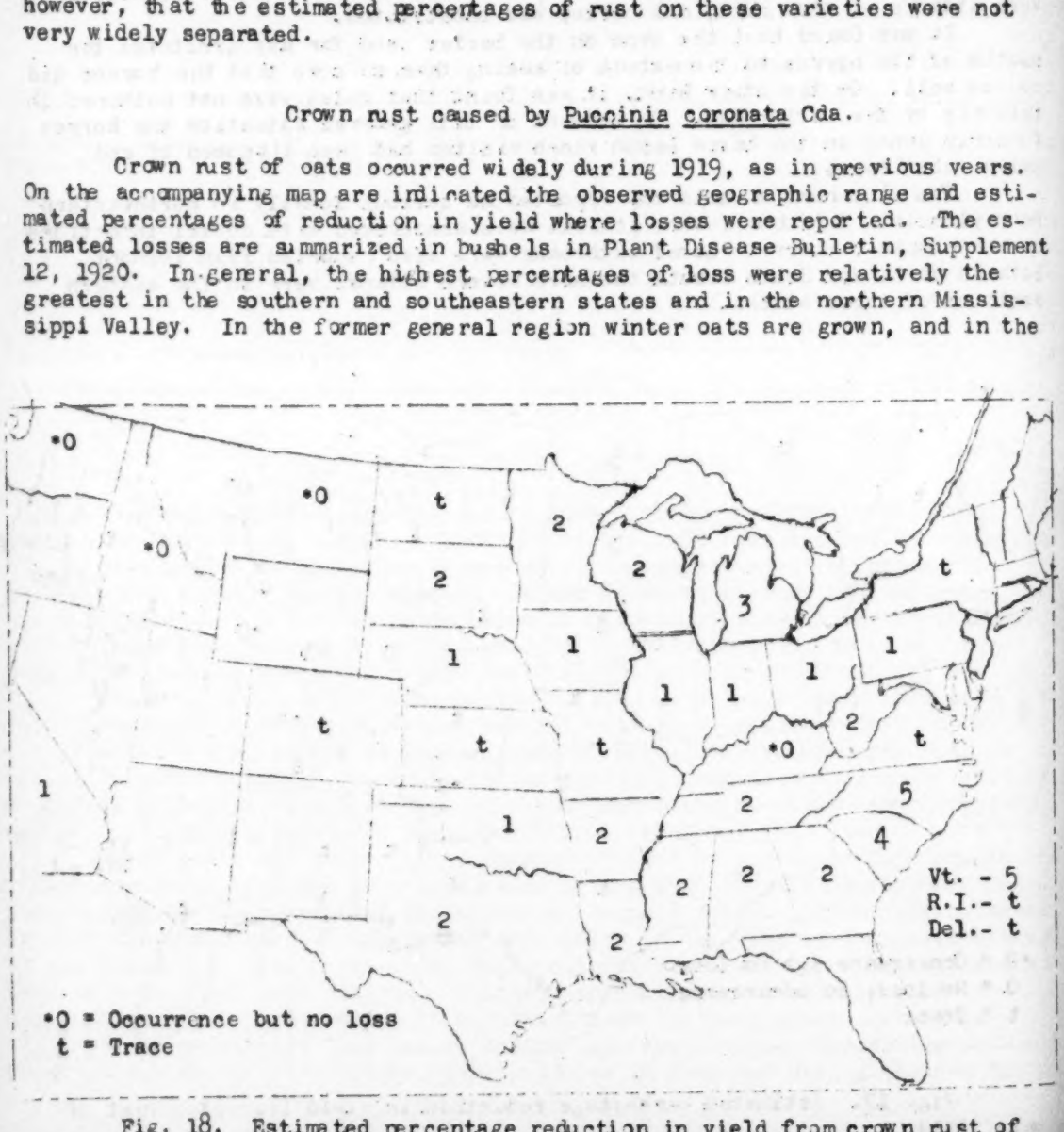


Fig. 18. Estimated percentage reduction in yield from crown rust of oats, 1919.

latter only spring oats are grown. The unusually open preceding winter and early spring made conditions unusually favorable for the rust development on oats in the southern and southeastern states in 1919, which no doubt accounts to a large extent for the losses there. In the northern Mississippi Valley the greatest losses occurred on late maturing varieties, which is usual. In the general region midway between, where losses from this rust are reported as being considerably less, the spring oats ripen earlier than farther north and tend to escape the later attacks from the rust. Furthermore, indications are that the buckthorn, which carries the aecial stage, is an important factor northward in starting epidemics of this rust. Definite cases of association between aecial infections on the buckthorn (Rhamnus cathartica) and heavy crown rust infections on oats were noted in Iowa, northern Illinois and southern Wisconsin; and it is suggested from Vermont that a similar condition may possibly obtain in that state also.

Infections were reported from South Carolina and Mississippi as early as April, from Tennessee May 15, from South Dakota June 24, Minnesota June 26, Wisconsin June, and Vermont July 15.

While no outstanding resistant varieties are reported, certain hybrids and varieties are reported as showing some promise in this direction. Peltier reported that in Alabama their Hybrid 615 rusted only 2%, and their T.R.P. No. 1020 also only 2%, while such varieties as Culbertson and Black oats No. 838, growing under similar conditions, rusted 65-100%. Melhus and Durrell reported from Iowa that Burt and Green Russian are proving somewhat resistant to this rust.

Scab (blight) of oats caused by Gibberella saubinettii (Mont.) Sacc.

Scab on oats was more general and more severe in 1919 than had ever been previously noted. Heretofore this disease on oats had been regarded as more or less of a curiosity.

In Illinois certain fields of oats were noted where the infection was very heavy, namely; more than 80% of the heads being affected and some of them entirely destroyed. This particular field had been in corn the preceding year.

In Iowa the disease was found general on oats, especially in Cherokee, Clay, and Kossuth Counties. In Scott County one field was noted with as much as 45% of the heads affected.

In Minnesota the disease was found at a number of points, especially in the southern parts of the state. In Murray County one field was noted where 65% of the heads were affected and in Nobles County a field with 25% was seen. In both of these cases it was noted that the preceding crop had been corn.

The disease was also noted in slight amounts in Wisconsin, Missouri, and Tennessee.

The estimated losses from this disease are comparatively small and not general. It is estimated that the yields in Minnesota and Illinois were reduced each approximately 1%. In the other states where the disease occurred the losses were but slight. These losses summarized in bushels are given in Plant Disease Bulletin, Supplement 12, 1920.

According to records in the files of the Office of Plant Disease Survey, the disease was apparently first reported by Pammel from Iowa in 1904 with the note that it was reported from two places in the state. In 1907 it was again

reported from Iowa; in 1910 from Delaware; in 1915 from Minnesota and Ohio; in 1916 from Ohio; in 1918 from Ohio and South Dakota.

Anthracnose caused by Colletotrichum cereale Manns.

Anthracnose was reported as occurring less commonly on oats than on wheat and rye in 1919. The disease was reported from Alabama, Minnesota, Missouri, Ohio, Virginia, and Wisconsin. It was reported by Freda Detmers as, "Very abundant in vicinity of Wooster, Wayne County, Ohio." She also reported that the formaldehyde wet method (1 pint to 40 gallons) "kills spores in acervuli on flowering glumes and those which may adhere to grain."

Other diseases.

Halo leaf blight of oats caused by Pseudomonas avenae Manns was reported from practically all of the oats growing states east of the 105th meridian and also from Idaho. It was reported as "Severe on oats seedlings" in Arkansas; unusually severe in Delaware, causing marked losses; "General but not destructive" in Iowa; "Not common" in Idaho. From Kansas, Melchers reported as follows: "Recorded from a few fields early in the season. Considerable excitement occurred in the southern part of the state in the early season due to some of this disease, but the plants soon outgrew the trouble."

Atanasoff and Johnson reported (Jour. Agr. Res. 18:386, 1920) perfect control of the seed borne infection of this disease by dry heat seed treatment.

Brown leaf blight of oats caused by Helminthosporium avenae-sativae (B. & C.) Lind. was reported from Washington, Idaho, Montana, Nebraska, Minnesota, Wisconsin, Indiana, New York, and West Virginia in 1919. Injury slight.

Powdery mildew on oats caused by Erysiphe graminis De C. was reported from California, Washington, Idaho, Wisconsin, and Ohio; practically all cases slight, except on Pacific Coast where some severe infections were noted.

Ergot caused by Claviceps purpurea (Fr.) Tul. was reported on oats from North Dakota and Minnesota.

Septoria sp. was reported on oats from Minnesota, Wisconsin, Missouri, and Kentucky as slight.

Foot rot of oats, fungus undetermined, was reported from western Washington by Heald and Dana.

Alternaria sp. was reported on oats from Missouri but the character of the attack was not stated.

Oats blast (sterility), cause not determined, was reported very generally from practically all of the oats growing sections east of the 105th meridian and from California, Washington, Idaho, and Montana.

"Red leaf" of oats, cause not definitely determined, was reported from Delaware, Pennsylvania, Michigan, Missouri, Illinois, and Washington. Heald states that reddening of the leaves and stunted, poorly filled panicles are the result of frost injury in Washington.

Frost injury to oats at heading time was reported from Idaho and Washington.

CORN

Smut caused by Ustilago zeae (Beck.) Ung.

Corn smut probably occurred in every state in the Union although it was rather rare west of the Rocky Mountains, perhaps largely on account of the scarcity of corn in that region.

In general the disease was more severe than in 1918. The states of New Jersey, Maryland, West Virginia, Ohio, Indiana, Michigan, Wisconsin, and Minnesota reported definitely that it was worse than usual. In Michigan it was said to be the chief subject of letters from farmers to the Department of Botany, and field agents of the U. S. Bureau of Crop Estimates reported an excess of smut in that state. The disease was said to be somewhat less than usual in the extreme northern and southern states of Vermont and Louisiana. The remaining states that reported noted it as present in about the usual amounts.

The percentage losses by states are indicated on the accompanying map. The following table also gives one an idea of the abundance of the disease in different states:

Table 18. Percentage affected corn plants according to collaborators.

State	Percentage affected plants	Maximum percentage reported
Pennsylvania	1-10 (Average 4)	33
Delaware	2-5	Over 40 in one field.
Maryland	---	44% in one field by count, (10% on ears).
North Carolina	10	---
South Carolina	15-20	---
Indiana	8	---
Michigan	---	25
Wisconsin	t-12	---
Minnesota	15-25 in Sherburne Co.	25
South Dakota	5	---
Iowa	7 on field corn, 15 on sweet corn	
Oklahoma	8	---
Colorado	10-25	25 or more

In Michigan counts in 10 fields near East Lansing showed smut on some part of the stalks to the extent of 10-12%. In Colorado, where 5% actual loss is estimated, it was said to be "the worst disease of the crop".

That this disease is influenced more or less by environmental conditions is indicated by the following quotations:

Wisconsin: "More in the southern than northern sections of state. More on light sandy soils than on heavy soils." R. E. Vaughan.

Kansas: "Very prevalent especially in the western part of the corn belt. The drier the region, the more corn smut." L. E. Melchers.

The following quotation from H. L. Bolley in North Dakota suggests the

possibility of seed transmission; "The amount present depends upon individual fields where certain types of seed are planted. There is some indication that this disease is transmitted with the seed, probably internally."

Sweet corn was almost universally reported as more affected than field corn; and pop corn, which was reported smutted in Indiana and Georgia, was even more susceptible than sweet corn in the latter state. Field and pop corn were observed by J. A. McClintock in Georgia, growing in adjoining rows with much more smut on the varieties of pop corn than on those of field corn.

In 1918 the pop corn varieties White Rice and Golden Queen were especially affected in Georgia. In Tennessee early corn was much more smutted than late corn. Very little smut was present in the late corn according to Essary.

Fig. 19. Estimated percentage reduction in yield from smut of corn, 1919.

Root, stalk and ear rots caused by Gibberella spp. and Fusarium spp.

Some, or all of the manifestations of these complicated troubles on corn were observed in 1919 in practically all states east of the 100th meridian. No reports were received, however, from northern New England. In fact the occurrence of these troubles in the entire northern tier of states seems to have been much more limited than farther south. The only indication of the presence of this trouble in the states west of the north and south line just mentioned, is the report of H. P. Barss from Oregon that "Fusarium is common in corn fields, but whether serious or not requires further study."

Until the last few years smut has been regarded as the only important corn disease in the United States; but more recently these root, stalk and ear rots have been found to be causing unusually large losses that were heretofore ascribed to other factors. It is evident that, as a group, these troubles cause far greater losses than corn smut and all the other corn diseases combined. The percentages of estimated loss for 1919, given on the accompanying map, are probably very conservative when all the various results of the disease, such as missing hills, stunted plants, barren stalks, nubbins, down stalks, ear rot, etc. are considered. Apparently the highest percentages of loss occurred in Tennessee, Kentucky and the surrounding states. Regarding the losses in Tennessee, S. H. Essary reported as follows:

> "This was by far the most destructive disease in the state this season. Very few fields were found without the infection. The estimates of losses are probably far too small. It was noted that where corn was grown continuously the disease was very serious, although it is found even in new fields. Some fields showed as high as 98% infection. It is believed that the disease is gaining."

Two fields were noted by C. H. Philpott in Missouri, with 75% and 60% reduction in yeilds. In both fields practically every plant was affected with root rot and there were many "down" stalks.

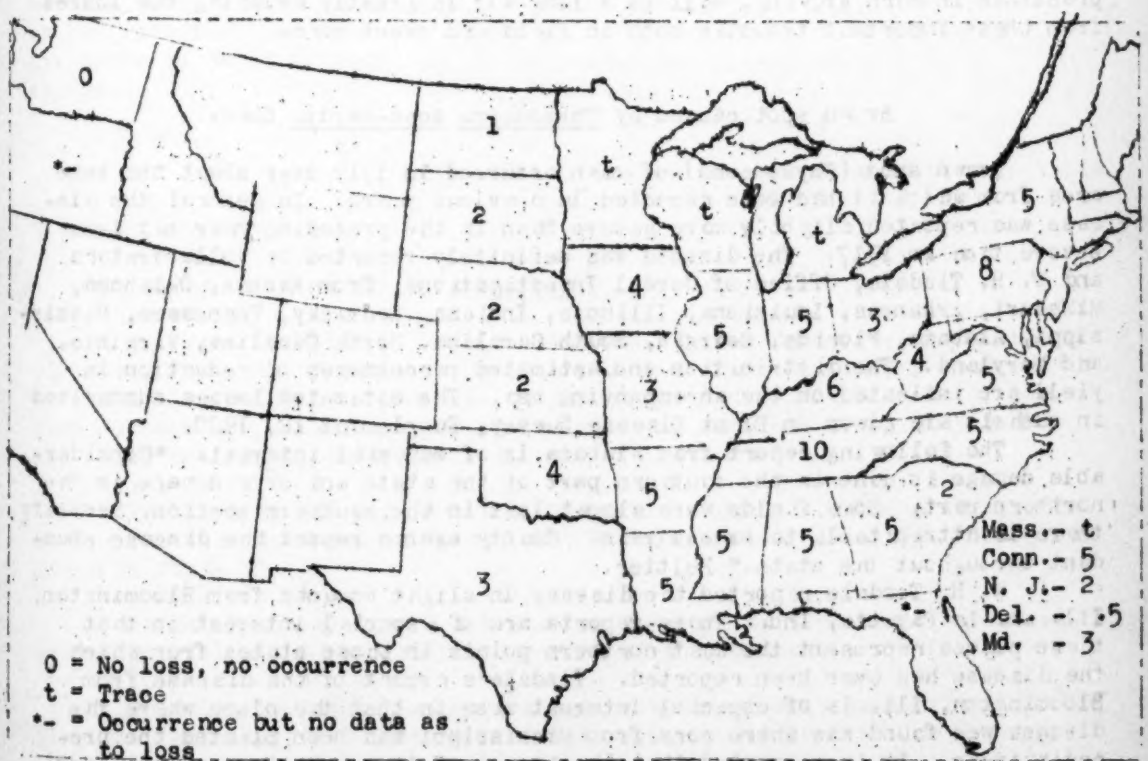


Fig. 20. Estimated percentage reduction in yield from root, stalk, and ear rots of corn, 1919.

On the Experiment Station grounds at Lexington, Kentucky, many barren stalks which broke over readily at the end of the season, occurred according to Valleau. He says further, "During June certain fields promised no crop but recovered and gave nearly normal yeilds. One field near Lexington was a total loss from root rot. Other fields on same farm in same rotation gave normal yield. Varieties not known. Many of the weak stalks seem to be due to nodal infections rather than to a systemic infection starting at the roots."

Very little on varietal differences was reported for 1919. The ear rot form of the disease was found in Minnesota on sweet corn and on the field varieties King Philip, Squaw Flint, Longfellow; and one of the root rot cases in Missouri occurred on St. Charles Yellow.

The bearing of certain of these troubles on rotation practices, particularly as bearing on wheat scab, has already been discussed under wheat scab (page 43).

Control measures for these troubles are not simple, nor are they as yet fully worked out. However, important beginnings have been made. The work of the Office of Cereal Investigations, carried on in cooperation with the Agricultural Experiment Stations of Indiana, Illinois, Iowa, and Wisconsin and with the Funk Bros. Seed Company, Bloomington, Ill., is indicating that the most careful attention to seed corn selections, both in the field and in the germinator, with the diseases in mind, together with the best agronomic practices in corn growing, will go a long way in greatly reducing the losses from these important troubles both on field and sweet corn.

Brown spot caused by Physoderma zeae-maydis Shaw.

Brown spot (Physoderma) of corn occurred in 1919 over about the same area from which it had been reported in previous years. In general the disease was reported slightly more severe than in the preceding year but less severe than in 1917. The disease was definitely reported by collaborators and W. H. Tisdale, Office of Cereal Investigations, from Kansas, Oklahoma, Missouri, Arkansas, Louisiana, Illinois, Indiana, Kentucky, Tennessee, Mississippi, Alabama, Florida, Georgia, South Carolina, North Carolina, Virginia, and Maryland. The distribution and estimated percentages of reduction in yield are indicated on the accompanying map. The estimated losses summarized in bushels are given in Plant Disease Survey, Supplement 12, 1920.

The following report from Alabama is of especial interest. "Considerable damage is done in the southern part of the state and some damage in the northern part. Some fields were almost lost in the southern section. Severity there is attributable to excess rain. County agents report the disease abundant throughout the state." Peltier.

W. H. Tisdale reported the disease in slight amounts from Bloomington, Ill. and La Fayette, Ind. These reports are of especial interest in that these places represent the most northern points in those states from which the disease has ever been reported. Tisdale's report of the disease from Bloomington, Ill. is of especial interest also in that the place where the disease was found was where corn from Mississippi had been planted the preceding year. It is suspected that the spores of the parasite may have been introduced with the Mississippi seed corn in 1918 and buried, as that corn was planted, and turned to the surface and ready for action as the land was plowed for the 1919 crop. This seems not unlikely since Tisdale reports

that he has secured normal germination of the Physoderma spores after two years storage under field conditions on the farm of Clemson College, South Carolina, both from material kept on the surface of the soil and from similar material buried three inches in the soil.

No varietal resistance was reported.

While long rotations and general clean up measures seem to be the most promising methods of control, it is not yet known how long the parasite is capable of remaining viable in the soil, or how resistant the spores may prove to be to various exposures.

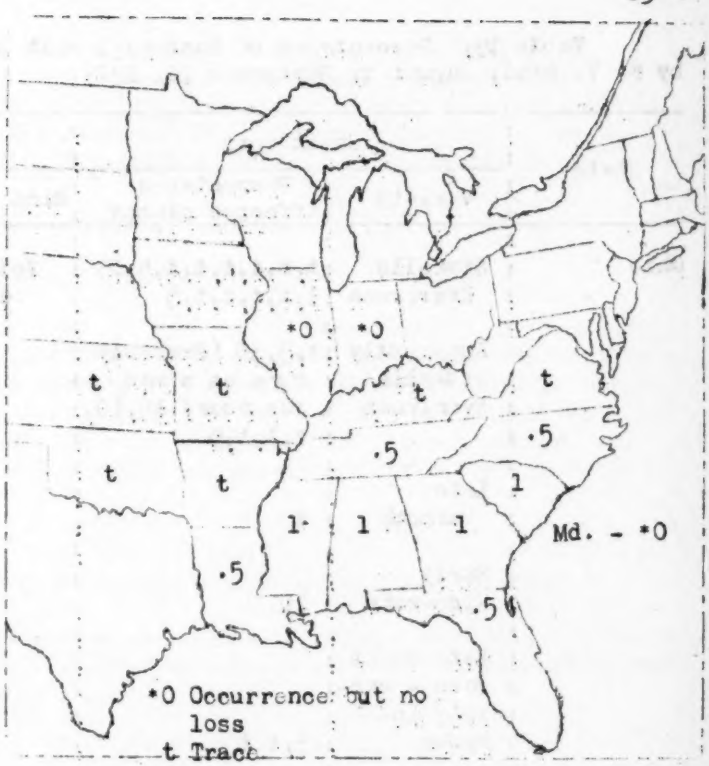


Fig. 21. Estimated percentage reduction in yield from brown spot of corn, 1919.

Bacterial wilt caused by Aplanobacter stewartii (Sm.) McC.

Observations of this disease were made in New York (Oneida County), Virginia, Kentucky, Tennessee, Georgia, Ohio, Indiana, Illinois, Iowa, North Dakota (Cass County), and Kansas. Although particularly a disease of sweet corn, it was not entirely confined to that crop as field corn, both yellow and white dent types, were found affected in some states.

Practically the only available figures, showing abundance of the disease, are those obtained by F. V. Rand, Bureau of Plant Industry. These are given in Table 19.

At the Kentucky Experiment Station the loss of some sweet corn varieties in trial plots was total on account of this disease.

The variety Golden Bantam was listed as especially susceptible in Virginia, Kentucky, and Indiana. At the Kentucky Station the low growing varieties, such as Golden Bantam and Peek-o-Day, were a total loss, while larger varieties were less susceptible according to Valleau.

Table 19. Percentages of bacterial wilt in individual fields observed by F. V. Rand, August to September 10, 1919.

State	Sweet corn		Field corn	
	Variety	Percentages affected plants	Kind of corn	Percentages affected plants.
Ohio	Stowells	t,t,t,t,t,t,5,15	Yellow dent	1,t,t,t,
	Evergreen	1,t,t,t,t,5		
	Apparently Stowells Evergreen	t,5,30 (Probably more as stand was poor) 15,10, t,t,t,5		
	Late Mammoth	t		
	Early Minnesota	10		
	Late sweet corn - variety unknown	5,t,t		
Indiana	Golden Bantam - mixed with white variety	30		
Tennessee	----	t (in several fields),5	White dent	t
Georgia	----	-----	White dent	t

Rust caused by Puccinia sorghi Schw.

Corn rust was reported as having occurred in about the usual amounts in the central and eastern states in 1919. In Indiana the disease was reported as somewhat less prevalent than usual; in Massachusetts it was both more prevaldnt and more severe, especially on sweet corn; and in Minnesota and Oklahoma it was reported as more general than in preceding years. It was first noticed in July in Wisconsin, Minnesota, Oklahoma, and Arkansas.

The reports of this disease from New Mexico (abundant) and Colorado (slight) were the first received by the Survey from either or these states, or from any state west of the corn belt, except California, where it was reported as slight locally in 1910.

The losses were reported as negligible, except in Louisiana, where practically all of the crop was injured and slight losses were sustained.

Both field and sweet corn, also pop corn in Minnesota, were attacked. Sweet corn was reported especially susceptible in Indiana and Massachusetts. In the latter state the variety Golden Bantam was said to be particularly susceptible.

Head smut caused by Sphacelotheca reiliana (Kühn) Clinton.

This rare and interesting smut of corn was collected by G. L. Zundel and B. F. Dana in two separate localities near Pullman, Washington in September. This is the first report of this disease of corn from Washington and is one of the first to be received by the Survey from any part of the United States. Melchers has stated that it occurs on corn in Kansas, but is not common, and Clinton (North American Flora, 7:30, 1906) has received collections from that state and from Ohio.

Leaf blight caused by Helminthosporium inconspicuum C. and Ell.

Collections of this disease were made in New Jersey, Kentucky, South Carolina, Ohio, and Minnesota. In South Carolina it was said to be common and occurred widely over the state.

Other diseases.

Ear rot caused by Diplodia sp., was reported from Delaware (not prevalent), Pennsylvania (slight), Ohio, Florida (local, as high as 10% in some cases), Louisiana (common, considerable loss), and Arkansas (common, 2% injury, considerable loss). In Pennsylvania C. R. Orton finds it developing on kernels in the laboratory that are being tested for presence of Fusarium. Some ear rot was found in Pennsylvania on the varieties Reid's Yellow Dent, College White Cap, and Millinger's Yellow Dent.

Purple sheathspot caused by various fungi in connection with pollen grains, aphis secretions, etc., (See Phytopath. 10:54, 1920) was said to be very common in Iowa by Melhus and Durrell.

Bacterial root rot, organism not determined, was reported from three counties in Arkansas by H. R. Rosen (Ark. Agr. Exp. Sta. Bul. 162:1-7, 1919). In two sections it was doing considerable damage.

A bacterial leaf spot was said to be general in Iowa, injuring about 1% of the plants but causing practically no damage. A similar disease occurred on sweet corn in Idaho in home gardens in Latah County; and a bacterial trouble was reported from Kansas by L. E. Melchers as follows: "In June and July a bacterial disease of corn was very conspicuous on the sheaths and the stem below the tassel. It seemed to be closely correlated with the large amount of aphids present. These, no doubt, figured in its spread."

Stem rot caused by Pythium de Baryanum Hesse, was reported by Sherbakoff as locally very severe in Florida. Flat cultivation was said to be helpful in control in that state. A trouble of a similar nature was also reported by G. P. Clinton in Connecticut. He stated that oospores, apparently those of a Pythium sp., were found at the base of the stalks.

Anthracnose of corn, a new disease, caused by an undetermined species of Colletotrichum, was found by G. P. Clinton near New Haven, Connecticut, July 8. It was said to be rather inconspicuous on the leaves and not causing much injury.

Cob rot, caused by Coniosporium sp., was reported from Ohio.

"Albino" corn, the leaves of which were striped with yellow, was collected in Connecticut by G. P. Clinton.

RICE

Blast caused by Piricularia oryzae Br. & Cav.

Blast ("rotten-neck") of rice was reported as prevalent throughout the southern rice growing sections. It is possibly the most important disease of rice. It was definitely reported either by collaborators or by W. H. Tisdale, Office of Cereal Investigations, from Arkansas, Texas, Louisiana, Alabama, Florida, and South Carolina. In an individual field in Florida observed by Tisdale the disease was found to be unusually severe, 100% of the plants being found infected, which resulted in about 50% loss. In Arkansas, Texas, and Louisiana, where most of the rice is grown in this general section, the disease, while usually present and causing slight damage, was not serious except in individual fields. The disease was not found in California. No practicable control measures are known.

Straight head (cause not known).

The so-called "straight head" (blight) of rice was found by W. H. Tisdale to be rather general throughout the rice growing sections of the south. It was definitely reported from Texas, Arkansas, Alabama, and South Carolina. It is one of the most important diseases of rice. In individual fields in the Mississippi Valley in Louisiana losses were reported as high as 50 to 90%. In southwestern Louisiana and eastern Texas, however, the disease is much less abundant. No control measures are known.

Smut caused by Tilletia horrida Tak.

Smut of rice was found by W. H. Tisdale to occur to a slight extent in the variety Honduras in Louisiana. No doubt it occurred more generally but was overlooked because it is not noticeable by general observations. The rice glumes must be broken open before the smut can be observed.

Green smut caused by Ustilaginoidea virens (Cke.) Tak.

Green smut of rice occurred to a very limited extent in Louisiana in 1919. During the entire season only a few diseased kernels were observed by W. H. Tisdale at Crowley, Louisiana. Not otherwise reported.

"Black speck" caused by Sclerotium sp.

The so-called "Black speck" of rice was found by W. H. Tisdale to occur on the leaves of the varieties Honduras and Blue Rose in Louisiana and Texas. Damage apparently very slight.

FLAX

Wilt caused by Fusarium lini Bolley.

Flax wilt was reported from North and South Dakota, Minnesota, and Wisconsin (only a trace) in 1919. The disease was unusually severe in North and South Dakota and Minnesota wherever non-resistant varieties of flax were by chance sown on infested land. H. L. Bolley reported as follows from North Dakota:

> "Wilt has been remarkably destructive this year on a wide range of territory, on all non-resistant flax which chanced to be planted upon wilt-sick soil. It proved to be extremely destructive where the flax was young during the very hot period of July. It never was more destructive in the vicinity of Fargo than it was during July of this year. Many other features have transpired to make wilt appear more destructive, namely; the abundance of crickets, grasshoppers, and other insects. These helped spread the disease under dry weather conditions."

Manley Champlin reported that in South Dakota select Russian flax was a total failure on land cropped to flax one, two, and four years previously. Where flax was sown on non-infested land the losses from wilt were negligible. In one case near Brookings, South Dakota, Champlin reports 50% loss from wilt.

As to wilt resistant varieties, N. D. R. 114 was reported the most resistant, In some cases N. D. R. 52 was also successful. H. L. Bolley made a special report as follows:

> "The variety known as N. D. R. 114 flax has proved strongly resistant, much more so than any other variety. There are many good crops of this variety in the Red River Valley this year, but even this variety came through much better in cases where it was planted early."

Canker (non-parasitic).

Flax canker was reported from North and South Dakota and Idaho in 1919. It no doubt occurred in Montana also as in previous years, although no definite reports were received. As to severity of the disease in 1919 but little defi-

nite information is at hand. In the Experiment Station plots at Mandan, North Dakota, however, the disease produced losses ranging from 2 to 50%. The greatest losses resulted in the plots where the soil was least shaded by crops and weeds. H. L. Bolley reported that the disease was "rather destructive in the early part of the season on certain new lands of the western portion of the state (North Dakota)."

As to the cause, experiments carried on by the Office of Cereal Investigations in cooperation with the North Dakota Experiment Station indicate that high temperatures at the ground-line when the flax plants are about one or four inches high, produce the typical canker regardless of fungi. A preliminary report on this work has already been made by C. S. Reddy and W. B. Brentzel. (Phytopath. 10: 66-67, 1920.) From investigations, indications are that a species of Colletotrichum may produce a special seedling blight and possibly may also attack stems to some extent, but typical canker is not produced by it.

As yet there are no indications of differences in varietal susceptibility. Control measures, as well as other phases of the problem, are being investigated by the Office of Cereal Investigations in cooperation with the North Dakota Experiment Station.

H. L. Bolley reported that "this disease seems to be more associated with new lands than with old, worked lands. It is always markedly more destructive in dry weather than in wet weather."

Rust caused by Melampsora lini (Pers.) Desm.

Flax rust was reported only from North Dakota and Minnesota in 1919. In North Dakota it was definitely observed at Mandan and Fargo: particularly severe at Fargo. In Minnesota it was definitely reported from Polk to St. Louis Counties.

While in general the losses from flax rust were slight, yet in certain localities the crop was severely injured. In these localities the injury ranged from a trace to 25%.

No differences in varietal susceptibility were reported.

As for control measures, avoiding continuous flax culture and sanitation by early sowing seem to be the most advisable.

SORGHUM

Covered kernel smut caused by Sphacelotheca sorghi (Link) Clinton.

This smut was reported on sorghum from Nebraska, (Kearney County), Missouri (Boone County), Arkansas (trace), Oklahoma (4 reports averaging 10%), Texas (2% loss), Minnesota (St. Louis County, Sept. 20), Washington (Douglas County, May 16).

Loose kernel smut caused by Sphacelotheca cruenta (Kuhn) Potter.

This smut was said to be present in Arkansas, troublesome in some regions in New Mexico, and abundant in Texas.

Head smut caused by Sphacelotheca reiliana (Kuhn) Clinton.

Head smut was reported from Tennessee, Arkansas, Kansas, Oklahoma, Texas, and New Mexico. In all states only slight amounts were reported.

Rust caused by Puccinia sp.

Reported from several places in Oklahoma. It was said to be uncommon, however.

Bacterial blight caused by Bacillus sorghi Burr.

This blight occurred in Iowa (common throughout the season, first reported June 19), Arkansas (general and severe, reported in June), and New Mexico (some damage, from 2-3% in some sections of the state).

FORAGE CROPS

A. LEGUMES.

ALFALFA (Medicago sativa)

Leaf spot caused by Pseudopeziza medicaginis (Lib.) Sacc.

As usual this disease occurred widely over the country. It was reported from 21 states and was said to be generally distributed within most of them. The losses on the late cuttings in Delaware ran as high as 35% in some fields. West Virginia reported a state loss of 10%, South Carolina 1%, Georgia 5%, Colorado 1-2%, and Idaho 2%.

In Delaware and Iowa it was said to be more severe on the late than on the early cuttings. In Wisconsin the reverse seems to be true. The dates when the disease was first noted by collaborators are as follows:

April	South Carolina	June 1	Georgia
April	New Mexico	June 2	Minnesota
May 26	Pennsylvania	July 16	Ohio
May 28	Indiana	August 16	Washington
May 30	Colorado	Sept. 15	Vermont
May 30	Missouri		

No varietal differences nor control measures were reported.

Yellow leaf blotch caused by Pyrenopeziza medicaginis Fckl.

Reported from South Carolina (common in mountainous section, causing some loss reported in May), Georgia (0-50% injury June 1), Kansas (common

locally on first and second crops, causing 15% loss in some instances, Idaho (general, 15% injury, about 2% loss), and Washington (Whitman and Klickitat Counties).

Anthracnose caused by Colletotrichum trifolii Bain.

Reported from Delaware, Ohio, South Carolina, Georgia, Oklahoma, and New Mexico. The only state reporting any particular damage was Georgia where as high as 25% injury occurred in some cases.

Root rots caused by Rhizoctonia spp.

Isolated cases of a root rot caused by a Rhizoctonia were noted by T. F. Manns in Delaware, and the violet root rot caused by Rhizoctonia crocorum (Pers.) De C. (R. violacea Tul.) was reported by Fromme from Rockingham County, Virginia, where 5% of the plants in one field were attacked; and from Kansas, where Melchers reported it common in various parts of the state, mostly in the older fields.

A resumé of past survey reports is of interest in connection with this summary. In 1906 and 1907 violet root rot was reported by Heald from points in east central Nebraska, where it was occurring in spots in numerous alfalfa fields. In 1914 it was reported to the Survey from Scott County, Iowa; Ford, Jefferson, Leavenworth, Butler, and Franklin Counties, Kansas; Botetourt County, Virginia (first occurrence in the East), and Washington County, Mississippi. In 1915 it was reported by J. C. Arthur from St. Joseph County in northern Indiana, and in 1917 by H. S. Jackson from LaPorte County in the same state. Since 1914 the disease has been reported practically every year from the Iowa, Nebraska, Kansas group.

Downy mildew caused by Peronospora trifoliorum De Bary.

No very serious losses from this disease were reported in 1919 although occurrences were noted in Pennsylvania, South Carolina, Iowa, Kansas, Colorado, Idaho, New Mexico, and Washington. J. G. Leach in Colorado reported 10-15% crop injury with 1-2% loss, and C. W. Hungerford in Idaho reported 10% crop injury with about 1% loss for the state. In Kansas the first crop was injured rather than the others. The disease was reported April 10 in New Mexico, May 26 in Pennsylvania, and May 30 in Iowa.

Root rot caused by Sclerotinia trifoliorum Erik.

Reported from Virginia (common), South Carolina (local in northwest), and Washington (less than usual). It was first noticed April 1 in Virginia, and May 15 in Washington.

Bacterial blight caused by Bacterium medicaginis Sackett.

This disease was reported from the West as follows: Colorado (25-50% injury and 1-2% loss. First reported June 29), Idaho (general in

southern Idaho, 5% injury, slight loss), Washington (weather not favorable for disease. First report May 14).

Root rot caused by Ozonium omnivorum Shear.

This rather limited trouble was reported only from Texas and Oklahoma. In Texas it was very prevalent in the eastern part of the state where it was estimated that about 40% loss reports were received from southern Oklahoma. The Hairy Peruvian variety was reported by Taubenhaus as showing slight resistance in Texas.

Other diseases.

Rust caused by Uromyces medicaginis Pass., was reported from Louisiana (common), Texas (unimportant), and Nebraska.

Leaf spot caused by Cercospora medicaginis reported from Denton, Dallas, and Kaufman Counties, Texas, causing a loss of about 1%.

Root knot caused by Heterodera radicicola (Greef.) Mull. was reported as causing about 1/2% loss in Texas. Hairy Peruvian showed some resistance.

Dodder (Cuscuta spp.). Reported from Texas and Washington.

A stem disease said to be caused by Diplodina medicaginis was reported by C. R. Orton from Halifax, Pennsylvania; on May 1 a 9-acre field showed 50% affected plants and the loss was estimated at 5%. The field was well fertilized and not in need of lime.

Stem spot, said to be caused by Ascochyta imperfecta, was reported from New Mexico by L. H. Leonian as follows: "Severe, causing 2% loss. First appeared early in April. First and last cuttings affected more than the others. Discoloration due to this disease reduces the price of alfalfa hay. No apparent weakening of the infected plants seen."

Stem disease, caused by Phoma sp., was reported by L. E. Melchers from Kansas as follows: "This was reported from different sections of the state, having been present more or less since 1915. It produces blackened lesions on the stems which in severe cases may cause them to crack."

Root rot, caused by Fusarium sp., was reported by Leonian from four counties in New Mexico. Two per cent loss was estimated for the state.

White leaf spot of unknown cause occurred fairly commonly in Idaho according to C. W. Hungerford.

Yellowing of alfalfa (non-parasitic) was noted in Lee County, Illinois; parts of Tennessee (severe locally May 26); Washington (slight, July 31); and a chlorotic condition, non-parasitic in nature, was rather common in southern Idaho, according to Hungerford, and caused slight loss.

Frost injury occurred to slight extent in Ohio and Washington according to the collaborators of those states.

CLOVER (Trifolium spp.)

Leaf spot caused by Pseudopeziza trifolii (Biv.-Bern.) Fckl.

This clover disease was reported as occurring less widely than the similar leaf spot of alfalfa. During 1919 it was reported on red clover from

Delaware, West Virginia, Ohio, Indiana, Iowa, Minnesota, and Washington. In most of these instances it was said to be of only slight importance but in West Virginia it injured a high percentage of the crop and was estimated as causing nearly 5% loss in that state. In parts of Ohio and Iowa it also did considerable damage.

Anthracnose caused by Colletotrichum trifolii Bain.

Anthracnose occurred on bur clover and on Medicago arabica in Louisiana where it was noticed doing considerable damage during March. It also was reported on clovers as occurring generally in Ohio (reported as Gloeosporium trifolii), Indiana and Illinois (reported as Gloeosporium caulivorum), and locally in South Carolina, Iowa (reported as Gloeosporium trifolii), and Missouri (reported as Gloeosporium caulivorum Kirch.) It is probable that there is more than one anthracnose of clover as is indicated by the different names for the occurrence. The dates when it was first noted in the central states, and which are more or less coincident, were given as follows:

May 10	Illinois	May 17	Indiana
May 13.....	Missouri	May 24	Ohio

Rusts caused by Uromyces spp.

Uromyces trifolii (Hed.) Lev. was reported on clover in Vermont, Connecticut, Delaware, Ohio, Arkansas, and North Dakota; on white clover (Trifolium repens) from South Carolina, Minnesota, and Oklahoma; and on alsike clover (T. hybridum) from Minnesota. The dates of first appearance of this rust were given as follows:

July 2	Minnesota	July	Oklahoma
July 25	Connecticut	September 15	Vermont

Uromyces fallens (Desm.) Kern. was noted on red clover (Trifolium pratense) in New Hampshire, New Jersey, South Carolina, Minnesota, Missouri, Nebraska, and Pennsylvania. In the latter state it was said to be less common than usual. The dates when this disease was first noticed are,-

June 9	New Hampshire	June 30	Pennsylvania
June 26	Missouri	July 20	Minnesota

Nematode disease caused by Tylenchus dipsaci (Kühn.) Bastian.

This disease, recently reported on by L. P. Byars (Phytopath 10: 91-95, 1920), and R. H. Smith (Jour. Econ. Entomology 12 : 460-462, 1919), was found during 1919 causing heavy losses to red clover crops in many localities in southern Idaho. A map supplied by Hungerford indicates its occurrence in Twin Falls, Cassia, Minidoka, Lincoln, and Gooding Counties, Idaho. According to Byars and Smith the disease is also known to occur on the crop in the irrigated regions of eastern Washington and Oregon, and in central Utah. Information obtained from farmers indicates that it has been present in southern Idaho for several years and has been rapidly increasing in destructiveness.

Regarding the severity of the disease Byars says, "In the Twin Falls, Idaho district it is difficult to find an uninfested field and the damage has been so severe that many farmers the past season have plowed up their clover and planted other crops." This important trouble should be closely guarded in regions where itsexists, and a sharp watch should be kept for occurrences in other sections or states.

Other diseases.

Sooty spot, caused by Phyllachora trifolii, occurred in Vermont, where a large proportion of the plants were more or less affected; in Delaware, where 1% injury was estimated; and in Minnesota, where it was collected on Trifolium repens (general, first report June 29), T. pratense (probably general, first report July 20), and T. hybridum (probably general, first report July 2).

Root rot, caused by Sclerotinia trifoliorum Erik., was reported from Ohio (May 5), Tennessee (severe locally on red clover, first seen April 22, and slight on crimson clover, first seen April 7), and Washington (Clarke County, March 21). The report from Washington is one of the first received by the Survey. It has been reported from Oregon, however, a number of times in the past.

Dodder (Cuscuta spp.) Cuscuta epithymum Murr. was said to be greatly on the increase in Delaware, injuring from 15-20% of the clover crop. Dodder was reported common in Arkansas clover fields.

Streak, caused by Bacillus lathyri Manns and Taub., was said by Manns to be common in Delaware, causing a stem blackening and leaf bacteriosis of red, alsike, and mammoth clovers. It was also reported from Hennepin County, Minnesota, June 13, by the Section of Plant Patholoty at St. Paul.

Leaf spot, caused by Cercospora medicaginis E. and E., was reported by E. F. Hopkins as general in Alabama and the cause of considerable loss. It was first noted by Hopkins, April 23.

Leaf spot, caused by Macrosporium sarciniforme Cav., was general late in the season, but not severe in Arkansas according to Elliott.

Crown rot, caused by Sclerotinia libertiana, was severe in parts of Delaware.

Powdery mildew, caused by Erysiphe polygoni, was reported from Washington, and Erysiphe martii was reported from Minnesota on alsike clover.

Root rots, of unknown causes, were reported by Hungerford from southern Idaho and by Leach from Colorado (June 7).

Mosaic, cause unknown, was observed by C. R. Orton on crimson clover in Pennsylvania. He reported as follows: "Fifty per cent of plants on 6 1/2 acres. Most serious case I have ever seen. Plants dwarfed and soon died, rosette produced in many cases. This crop was newly seeded in an orchard."

The disease was also said to be common on red and sweet clovers in Arkansas, where it was noted first in May.

Red leaf, of unknown cause, occurred in Pennsylvania in the same field mentioned above under mosaic. Orton stated that this condition may be associated with the mosaic, but the evidence was not very strong in that direction. The damage was severe.

VETCH (Vicia spp.)

Blight, caused by Ascochyta pisi Lib. was reported from Delaware.

Downy mildew, caused by Peronospora viciae (Berk.) De Bary., was collected on Vicia sativa in the District of Columbia. It occurred locally on the lower parts of the plants.

SWEET CLOVER (Melilotus)

Leaf spot, caused by Cercospora davisii Ell. & Ev. reported from Hennepin County, Minnesota, July 20 on Melilotus alba.

Root rot, caused by Fusarium sp., was said to be severe in New Mexico where 5-90% of the plants were affected. It was found both along the banks of the irrigation ditches and in the fields, according to Leonian.

Ascochyta caulicola Laub., reported from Jefferson County, Indiana, May 23.

COWPEA (Vigna sinensis)

Leaf spot, caused by Cercospora cruenta Sacc., occurred in the following states according to collaborators: New Jersey (common), Georgia (general, 5%, first appeared Aug. 1), Arkansas (common, 50% crop injury), Oklahoma and Texas (prevalent, 1% loss).

Powdery mildew, caused by Erysiphe polygoni De C., was common in South Carolina and Georgia. In both of these states it occurred on a large percentage of the crop and appeared in August.

Wilt, caused by Fusarium sp., was reported from Georgia (general in South, causing 10% loss), Arkansas (scattered), and Louisiana (common in some localities, local variety of black pea in Webster Parish reported by Hollis to be entirely resistant).

Root knot, caused by Heterodera radicicola (Greef.) Mull., was reported common in South Carolina (5% loss), and Arkansas (2% loss). It also caused damage in many other parts of the South but no other reports were received by the Survey.

Leaf spot, caused by Amerosporium oeconomicum Ell. & Tracey, was common in South Carolina.

Pod spot, caused by Cladosporium sp., was found on pods in Cobb County, Georgia, July 21, by G. M. Armstrong. It was also common in Florida, affecting nearly 25% of the crop according to Sherbakoff.

Anthracnose, caused by Colletotrichum, reported from Delaware.

Streak, caused by Bacillus lathyri M. and T., was reported by Manns from Delaware.

Root rot, caused by Ozonium omnivorum Shear, was very prevalent in Texas and present in Oklahoma.

Leaf spot, caused by Phyllosticta phaseolina Sacc., was collected in Jackson County, Indiana, August 29.

Rust, caused by Uromyces sp., was reported by Taubenhaus from Texas.

Rhizoctonia sp., was reported by Matz from Porto Rico, attacking the foliage and pods. The fungus was also said to be the cause of serious root rot in St. James Parish, Louisiana.

SOY BEAN (Soja max)

Bacterial blight, caused by Bacterium glycineum, occurred naturally in the varietal test plots at the Experiment Station at Madison, Wisconsin.

Streak, said to be caused by Bacillus lathyri Manns and Taub., was common in Delaware last year.

A stem rot of undetermined cause was reported in parts of Tennessee. Whole fields showed dwarfed and yellowed plants. A report of a somewhat similar trouble was reported from Clermont County, Ohio.

A leaf spot, cause not given, was collected in Ohio.

VELVET BEAN (Stizolobium deeringianum).

Bacterial leaf spot, caused by Aplanobacter stizolobii Wolf., recently described by Wolf (Phytopath. 10 : 73-80, 1920), occurred in North Carolina, where it had been present in varying amounts during the past four years in widely separated portions of the state.

B. GRASSES

(The nomenclature of grasses is that used by Hitchcock, U. S. Dept. Agr., Bur. Pl. Ind. Bul. 772, 1920.)

TIMOTHY (Phleum pratense L.)

Powdery mildew caused by Erysiphe graminis De C. was reported by the Section of Plant Pathology from Sherburne County, Minnesota; first found June 4.

Ergot caused by Claviceps sp. was found in seven counties in Minnesota. The first record of its occurrence was made July 11.

Leaf blight caused by Scolecotrichum graminis Fckl. was reported from Minnesota (McLeod County, first found June 26), Wisconsin (Dane County), and Idaho (reported by Chas. W. Hungerford as generally prevalent but causing slight loss.)

Scab caused by Fusarium sp. was reported from Ramsey County, Minnesota; first record July 7.

Leaf smut caused by Ustilago striaeformis (West.) Niess. appeared in Pennsylvania (slight loss in Center County; earliest record May 26), Minnesota (Isanti County; first reported June 5), Wisconsin (slight), Iowa (a trace reported by I. E. Melhus; also recorded from Ames on June 19), and Idaho (common in Latah County, but causing only slight loss).

Stem rust caused by Puccinia phlei-pratensis Eriks. & Henn. occurred in Connecticut (occasionally found in New Haven County), West Virginia (generally found in parts of Greenbrier and Summers Counties), Ohio (less prevalent than in preceding years), Minnesota (in 21 counties, causing a loss estimated at 2% for the state; earliest report from Hennepin County, May 30),

Missouri (Boone County, loss slight; also reported from Greene County), Idaho (occurrence general, but loss caused very slight).

A blade blight, apparently bacterial, was reported from Ohio by Selby.

RED TOP (Agrostis palustris Huds.)

Powdery mildew caused by Erysiphe graminis De C. was reported from St. Louis County, Minnesota; first found September 17.

Stem rust caused by Puccinia graminis Pers. occurred in West Virginia (generally prevalent and causing severe damage in parts of Summers County; June 24) and in Tennessee (locally severe in Cocke and Unicoi Counties; first observed July 7).

BLUE GRASSES (Poa spp.)

Ergot caused by Claviceps sp. was reported from Minnesota on Poa compressa L. in Lake County (earliest record September 24), and on P. pratensis L. in four counties (first report June 26).

Powdery mildew, caused by Erysiphe graminis De C. was reported on P. pratensis in Minnesota (in 11 counties; injury ranging from slight to severe), and Kansas (generally prevalent in Riley County; injury slight).

Silver top caused by Sporotrichum sp. was common in Iowa.

A leaf spot caused by Septoria sp. on P. pratensis was found in McLeod County, Minnesota; first reported June 26.

A leaf spot caused by Scolecotrichum graminis Fckl. was found on P. pratensis in Fillmore County, Minnesota; first reported June 6.

Anthracnose caused by Colletotrichum cereale Manns. was reported on P. pratensis in Ramsey County, Minnesota; first report August 13.

Leaf rust caused by Puccinia poarum Niess. was reported from Minnesota (on P. compressa in Ramsey County, first report June 30; on P. pratensis in nine counties, injury ranging from slight to moderate, first report May 30, Hennepin County), Iowa (reported as general on Poa sp. in the northern half of the state, appearing very early, June 9-11), Kansas (on P. pratensis in Riley County, May 15), and California (2% infection found on P. compressa May 10).

EUROPEAN MILLET (Panicum miliaceum L.)

Smut caused by Ustilago panici miliacei (Pers.) Wint. was reported as causing slight injury in Colorado. The first record of its occurrence was October 30.

ITALIAN MILLET (Chaetochloa italica (L.) Scribn.)

Smut caused by Ustilago crameri Körn. was found in Minnesota (Ramsey and St. Louis Counties; first report August 2, Ramsey County), and North Dakota (slight infections in Grand Forks and Traill Counties; moderate in Cass County).

ORCHARD GRASS (Dactylis glomerata L.)

Ergot caused by Claviceps sp. occurred in Rice and Ramsey Counties, Minnesota; first report June 25.)

Powdery mildew caused by Erysiphe graminis De C. was reported August 19 from Rice County, Minnesota.

Scab caused by Fusarium sp. was reported as general in certain localities in Greenbrier County, West Virginia.

Anthracnose caused by Colletotrichum cereale Manns. was reported from Minnesota (Ramsey County; first report August 3.)

Stem rust caused by Puccinia graminis Pers. was reported from West Virginia (locally prevalent in Greenbrier and Summers Counties) and Minnesota (in four counties; first report from Todd County, July 4).

BROME GRASSES (Bromus spp.)

Ergot caused by Claviceps sp. was reported on Bromus inermis Leyss. in Minnesota (slight to moderate infections in six counties; first report July 4). It was also reported abundant on Bromus sp. in Cass County, North Dakota.

Powdery mildew caused by Erysiphe graminis De C. was found on B. inermis in Minnesota (Fillmore County).

Leaf spot caused by Helminthosporium sp. was found on B. inermis in Ramsey County, Minnesota, and in three counties in North Dakota.

Scab caused by Fusarium sp. was found on Bromus sp. in Greenbrier County, West Virginia.

Leaf rust caused by Puccinia sp. was found in California on B. hordeaceus L. (April 25 and May 10; amount of infection ranging from 5% to 40%), B. secalinus L. (May 31) and B. villosus Forsk. (leaf rust almost universal; May 6).

Stem rust caused by Puccinia graminis Pers. occurred in West Virginia (Greenbrier and Summers Counties, locally prevalent on B. secalinus); Minnesota (present in slight amounts on B. purgans L. in Ramsey County; first report August 14); and North Dakota (on Bromus sp. in Cass County).

BERMUDA GRASS (Capriola dactylon (L.) Kuntze.)

Leaf rust caused by Puccinia cynodontis La C. was found in California to be prevalent on Bermuda grass along irrigation ditches (April 23).

Rust caused by Puccinia sp. was found in California.

BLUE JOINT GRASS (Calamagrostis canadensis (Michx.) Beauv.)

Ergot caused by Claviceps sp. was found in Minnesota (slight to moderate infections in Hennepin and Washington Counties; first report July 15.)

Leaf spot caused by Phyllachora graminis (Pers.) Fckl. was found in Minnesota (abundant in Washington County; first report August 3).

Rust caused by Puccinia sp. was reported from Washington County, Minnesota (slight injury; first report August 3).

BOTTLE BRUSH GRASS (Hystrix petula Moench.)

Epichloe typhina (Pers.) Tul. was abundant in Ramsey County, Minnesota; first report June 24.

Leaf spot caused by Phyllachora graminis (Pers.) Fckl. occurred frequently in Hennepin, Rice, and Ramsey Counties, Minnesota; first reported July 12.

BRISTLY FOXTAIL GRASSES (Chaetochloa spp.)

Downy mildew caused by Sclerospora graminicola (Sacc.) Schr. was reported from Minnesota (in six counties on Chaetochloa viridis (L.) Scribn.; first report July 19), and Iowa (very common).

Smut caused by Ustilago neglecta Niessl. was reported on C. lutescens (Weigel) Stuntz from seven counties in Minnesota (first report Ramsey County, July 13).

CANARY GRASS (Phalaris spp.)

Ergot caused by Claviceps sp. occurred rather commonly on Phalaris arundinacea L. in Ramsey and Goodhue Counties, Minnesota; first report July 21.

Leaf rust caused by Puccinia majanthae (Schum.) A. &.H. was found in California on P. canariensis L.

Stripe rust caused by Puccinia glumarum (Schm.) E. & H. was found by W. W. Mackie in California on Phalaris paradoxa L.

CRAB GRASS (Syntherisma sanguinalis (L.) Dulac.)

Leaf spot caused by Piricularia grisea (Cke.) Sacc. was reported from Goodhue County, Minnesota; first report July 17.

Smut caused by Ustilago rabenhorstiana Kühn occurred in Goodhue County, Minnesota; first report July 24.

FESCUE GRASSES (Festuca spp.)

Ergot caused by Claviceps sp. was found in Minnesota on Festuca elatior L. (Hennepin and Ramsey Counties; first report July 11), F. pratensis Huds. (Ramsey County, July 10), and F. rubra-heterophylla (abundant in Ramsey County, first report July 10).

Anthracnose caused by Colletotrichum cereale Manns. was reported from Minnesota on F. elatior (Ramsey County, August 13), F. ovina L. (considerable in Ramsey County; first report August 13), and F. rubra L. (Ramsey County).

A leaf spot caused by Helminthosporium sp. was very common in Iowa.

Stem rust caused by Puccinia graminis Pers. occurred on F. elatior in Freeborn County, Minnesota; first report July 2.

MARSH GRASS (Spartina michauxiana Hitch.)

Leaf spot caused by Phyllachora graminis (Pers.) Fckl. occurred in Washington County, Minnesota; first report August 3.

MEADOW FOXTAIL GRASSES (Alopecurus spp.)

Anthracnose caused by Colletotrichum cereale Manns. was found in Ramsey County, Minnesota, on Alopecurus aristulatus Michx. (first report June 28), and on A. pratensis L. (August 13.)

OAT GRASS (Arrhenatherum elatius (L.) Mert. & Koch.

Anthracnose caused by Colletotrichum cereale Manns. was found in Ramsey County, Minnesota.

PANIC GRASSES (Panicum spp.)

Anthracnose caused by Colletotrichum cereale Manns. occurred in Minnesota on Panicum capillare L. (Hennepin County, May 24) and P. virgatum L. (Washington County, August 3).

Rust caused by Puccinia emaculata Schw. was found on P. capillare in McLeod County, Minnesota; first report August 20.

Rust caused by Puccinia panica was reported on P. virgatum in Washington County, Minnesota; first report August 3.

PASPALUM GRASSES (Paspalum spp.)

Ergot caused by Claviceps paspali S. & H. occurred in Louisiana (generally prevalent and severe in several parishes, causing death of cattle in pastures; traces found in Tangipahoa Parish wherever Paspalum was found, no damage to cattle; traces found locally in Calcasieu County, and in Arkansas (very general, injury 90%; earliest report September).

PORCUPINE GRASS (Stipa spartea Trin.)

Smut caused by Ustilago hypodytes (Schl.) Fr. was reported from Waseca County, Minnesota, July 17.

REED GRASS (Calamovilfa longifolia (Hook.) Scribn.

Epichloe typhina (Pers.) Tul. was abundant in Washington County, Minnesota; first reported August 3.

RYE GRASS (Lolium perenne L.)

Stem rust caused by Puccinia graminis Pers. was reported from Minnesota (Ramsey County, first report August 14).

Stripe rust caused by Puccinia glumarum (Schm.) E. & H. occurred in Yakima and Whitman Counties, Washington.

SALT GRASS (Distichlis spicata(L.) Greene)

Rust caused by Puccinia subnitens Diet. was found in California.

SQUIRREL-TAIL GRASS (Hordeum jubatum L.)

Leaf spot caused by Scolecotrichum graminis Fckl. was reported from Ramsey County, Minnesota, June 21.

Leaf spot caused by Septoria graminum Desm. was found in Freeborn County, Minnesota, July 2.

Leaf rust caused by Puccinia sp. was reported as probably general in Hennepin, Ramsey, St. Louis, Todd, and Wadena Counties, Minnesota; first report from Todd County, July 4.

Stem rust caused by Puccinia graminis Pers. occurred in 22 counties in Minnesota (slight to abundant; first report Hennepin County, June 17).

WHEAT GRASSES (Agropyron spp.)

The following diseases were reported on Agropyron spp. in Minnesota:

Ergot caused by Claviceps sp. occurred on A. caninum (L.) Beauv. (Stevens and Hennepin Counties; first report July 18); A. cristatum (L.) Gaertn. (Ramsey County; first report July 1); A. desertorum (Ramsey County, first report July 1); A. intermedium (Ramsey County; first report July 1); A. repens (L.) Beauv. (causing slight to severe damage in ten counties; first report July 1); A. smithii Rydb. (slight to considerable amounts found in eight counties; first report July 15); A. tenerum Vasey (Dakota, Hennepin, and Stevens Counties; first report July 15).

Powdery mildew caused by Erysiphe graminis De C. was found on A. caninum in Ramsey County (first report May 30), and on A. repens in Rice and Ramsey Counties (first report June 2, Ramsey County).

Black leaf spot caused by Phyllachora graminis (Pers.) Fckl. was reported as probably general on A. repens in Anoka, Chisago, and Ramsey Counties; first report July 5.

Scab caused by Fusarium sp. occurred on A. smithii in Anoka and Ramsey Counties (first report August 4, Ramsey County).

Anthracnose caused by Colletortichum cereale Manns. was found in Ramsey County on A. desertorum (first found August 13) and on A. repens (first report July 27).

Leaf spot caused by Septoria graminum Desm. was reported from Stevens County on A. caninum (first report July 28).

Smut caused by Ustilago macrospora Desm. occurred on A. repens in Ramsey County; first report July 28.

Leaf rust caused by Puccinia clematidis was found on A. caninum in Stevens County, July 28; on A. repens in Hennepin (abundant), McLeod, Washington,

and Rice Counties (first report June 26); and on A. tenerum in Stevens and Waseca Counties (first report July 17).

Stem rust caused by Puccinia graminis Pers. occurred on A. caninum in Stevens, Hennepin, and Anoka Counties (damage slight, first report July 28, Stevens County); on A. repens in 14 counties (generally prevalent, causing slight to severe injury; first report June 17, Hennepin County); on A. smithii in Anoka County, September 4; on A. tenerum in five counties (general; injury ranging from moderate to severe; first report July 28, Stevens County).

WILD OATS (Avena spp.)

Powdery mildew caused by Erysiphe graminis De C. occurred in California (May 28).

Stem rust caused by Puccinia graminis Pers. was found in California (May 28).

WILD RYE (Elymus spp.)

The following diseases were found on Elymus spp. in Minnesota:

Ergot caused by Claviceps sp. occurred on E. robustus Scribn. & J.G.Sm. in Nobles County (first report September 6), and on E. virginicus L. in Stevens County.

Epichloe typhina (Pers.) Tul. was found on E. canadensis L. in Anoka, Hennepin, and Ramsey Counties (injury moderate to severe; first report June 29, Hennepin County); on E. robustus in Ramsey County (damage considerable; first report July 13); and on E. virginicus in Ramsey and Hennepin Counties (injury slight, first report June 24.

Powdery mildew caused by Erysiphe graminis De C. occurred on E. canadensis in Ramsey County (first reported June 14); on E. robustus in Washington County (first record August 3); and on E. virginicus in Hennepin County (first appeared July 15.

Leaf spot caused by Phyllachora graminis (Pers.) Fckl. was reported on E. canadensis in five counties (probably generally prevalent, injury moderate to severe; first report July 13); on E. robustus in five counties (damage slight to considerable; first report Anoka County, July 5); on E. striatus Willd. in Hennepin County (abundant; first report August 3); and on E. virginicus in four counties (considerable to abundant; first report July 21).

Smut caused by Ustilago striaeformis (Schl.) Fr. was reported on E. canadensis glaucifolius (Muhl.) Gray in Ramsey County (first report June 22); and on E. robustus in Dakota and Rice Counties (first report (July 20).

Stem rust caused by Puccinia graminis Pers. was found on E. canadensis in Anoka County (September 4); on E. glaucus Buckl. in Swift County (injury very slight; first report July 28); on E. macounii Vasey in Carlton County (considerable; first report September 15); on E. robustus in five counties (abundant in Sherburn County; first report from Ramsey County, July 15); on E. virginicus in Stevens County (injury slight; first report July 28).

A Septoria leaf spot was common and severe in Iowa on Elymus sp. (wild barley).

Leaf rust caused by Puccinia sp. was found on E. triticoides Buckl. in California (5% infection, May 22).

Stem rust caused by Puccinia graminis Pers. was reported from California on Elymus sp. (5% infection, June 29).

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